20/10/2014

Digital Communication

what is the digital communication?

Conversion of analog signal into digital
Transmission of the digital signal

why digital signal?

Because It have more advantage
coding - decoding
low noise
Low distortion
Low interfernce

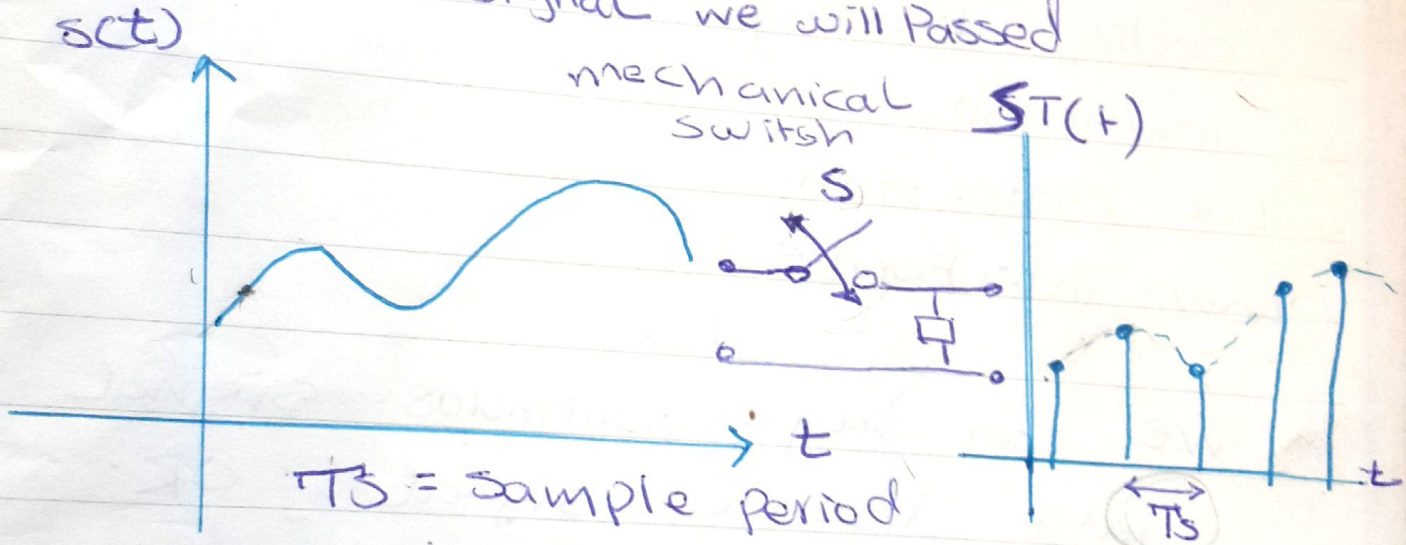
we can say continuos signal into discrete signal OR to covert analog signal into digital

* there are three stages to convesion :-

1. Sampling
2. Quantization قياس الفولتية - معرفة القيمة
3. Coding : conversion into digital

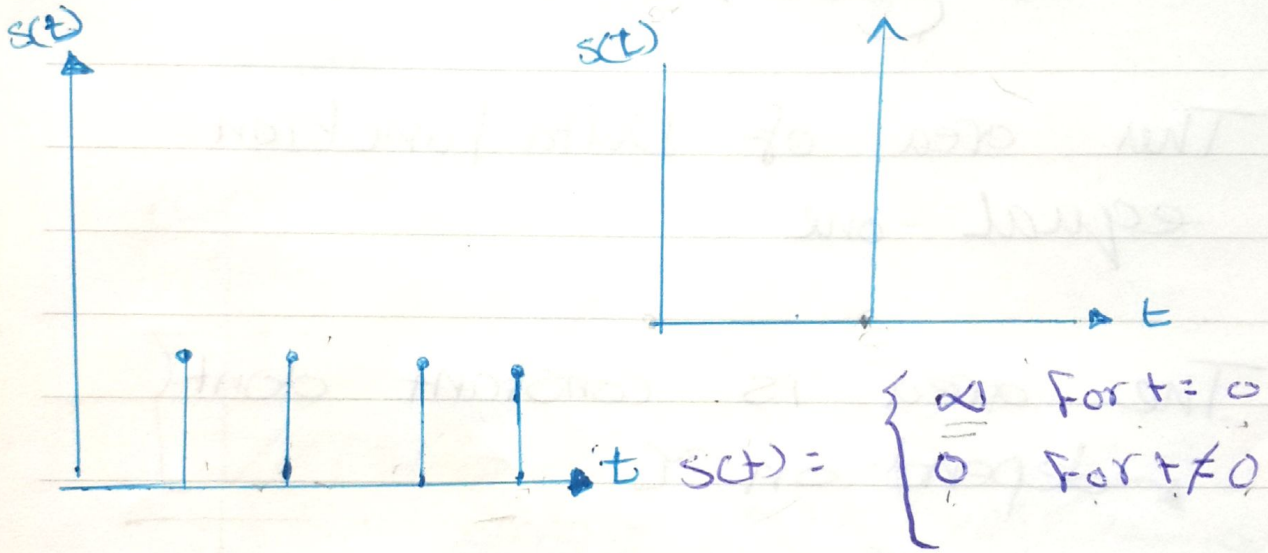
* Quantization
to divid the signal into number of levels.

- Sampling = أخذ العينات
taken samples from the signal
= أخذ منه جزء معين وتتغير منه
بعد ذلك
continuos signal we will Passed



يكون المفتاح مفتوح ومقفول لزمن محدد
لذلك نلاحظ ان الاشارة تكون
مقطعة
بدل ارسال الاشارة كلها نرسل عينات
منفصلة
وتكون العينة تمثل مستوى الفولتية
في الزمن المحدد

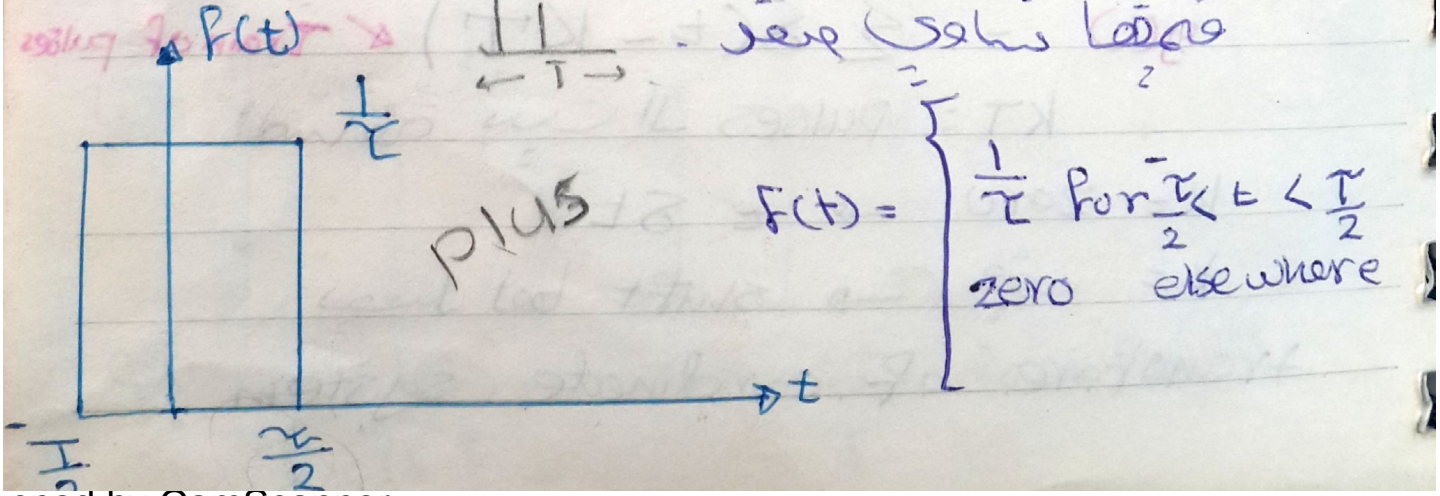
شبه دلتا المفتاح الميكانيكي البعيد
لذلك نستخدم المفتاح الرقمي digital switch



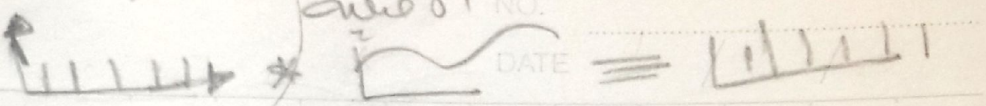
Delta Function δ-

which has infinite voltage when at atime equal zero otherwise it equal zero

اذا جولنا الزمن الى T تكون لديها قمة عند الزمن المحول وفي الازمان الاخرى تكون قيمها تساوي صفر.



impuls × = samples



Another definition -

$$\delta(t) = \lim_{\tau \to 0} f(t)$$

Delta fun = impulses

∞ الارتفاع , zero العرض

The area of Delta function equal one

- The area is constant dont depend on τ.

area = طول × عرض

$$\int_{-\infty}^{\infty} \delta(t) \cdot dt = 1$$

the area under integration or curve.

Delta fun اذا كانت لدينا مجموعة من ال impuls نقوم بجمعها

$$y(t) = \sum \delta(t - kT_s)$$ ← Train of pulses

T_s تأخير الدالة

kT : pulses بين ال المسافة

k = zero → = δt

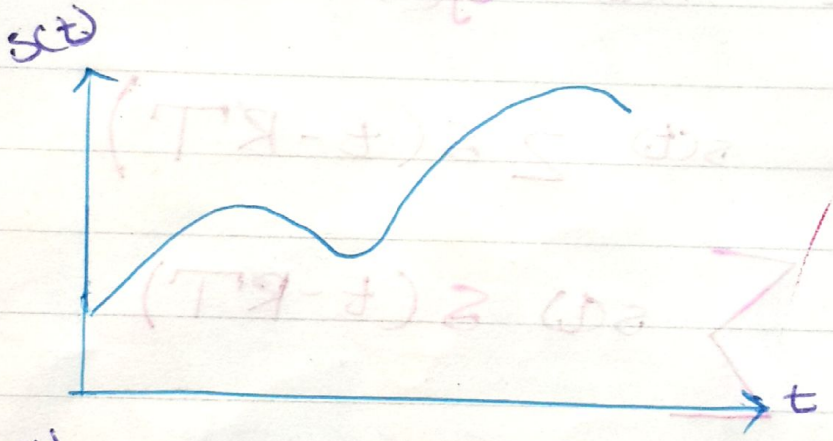
k = عدد → shift لجعل

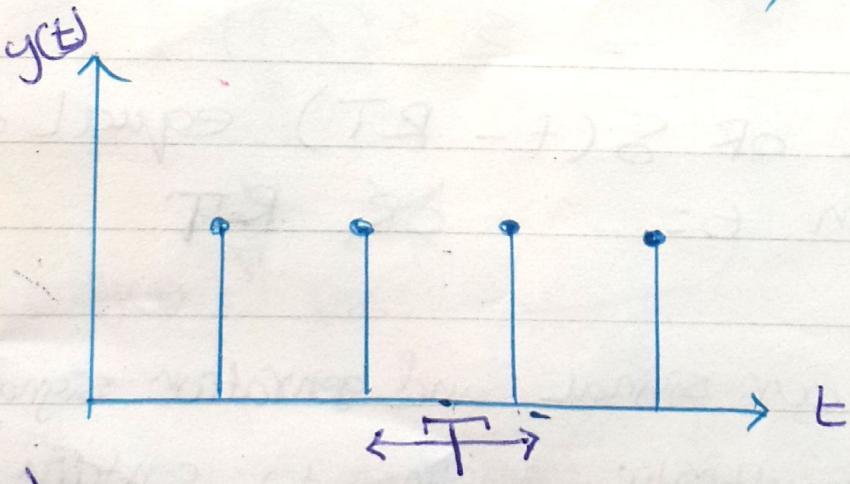
transfare of cardinate system ??

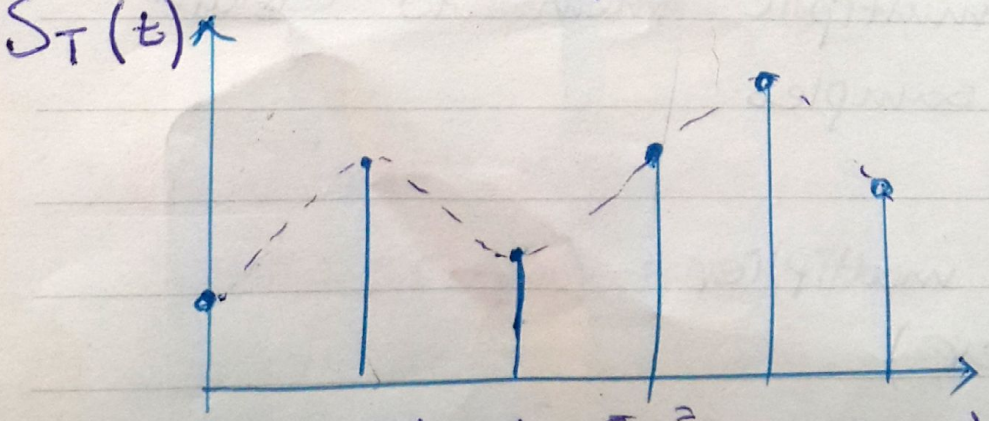
* impulses :-

the limit of pulse when τ = zero

train of







level الـ قيمة تعني وقت واحد

Delt Fandron = 1

Transistor

Mathmitical exprtion of sampling

$$S_T(t) = s(t) \cdot g(t)$$

$$\delta_T(t) = s(t) \sum \delta(t - RT)$$

$$\delta_{T'}(t) = \sum s(t) \delta(t - RT)$$

samples

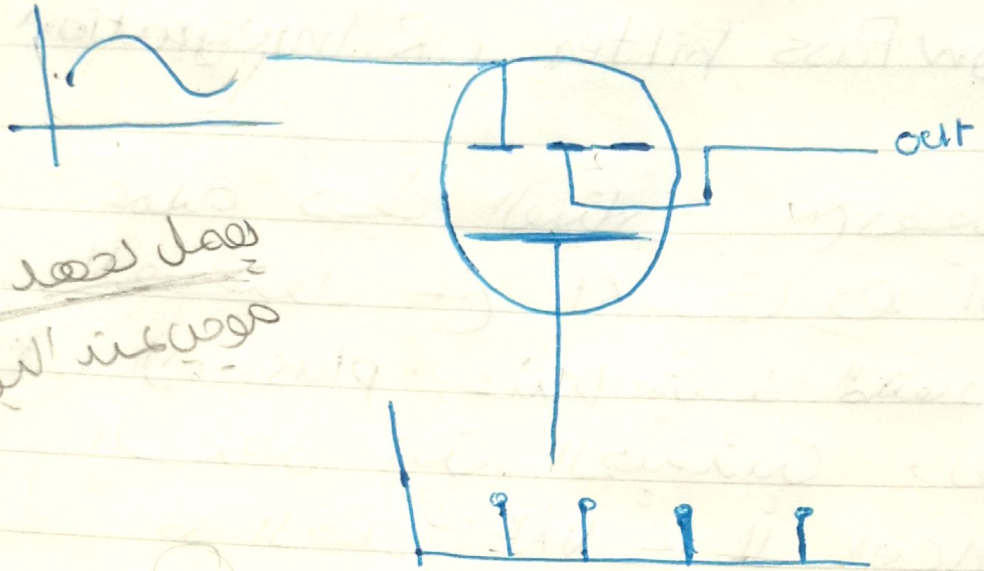
$$= \sum s(kT)$$

the level of $\delta(t - RT)$ equal one when $t = RT$

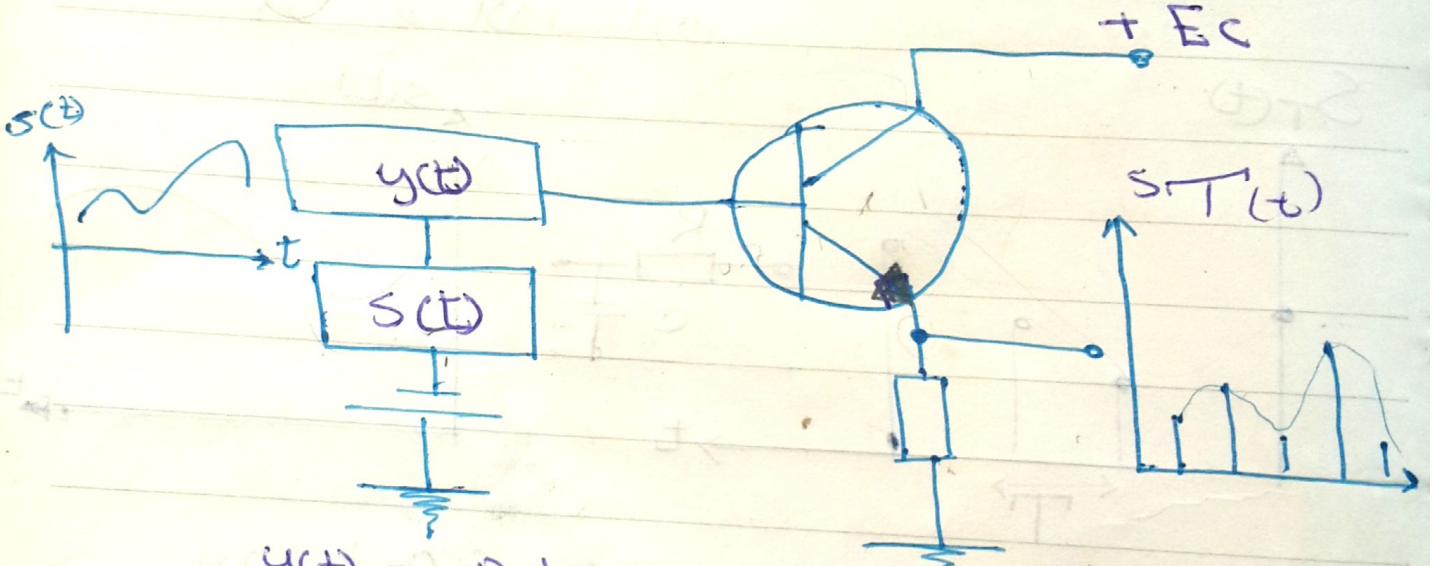
we have our signal and genration signal of $\delta(t)$ and multiplie them to contain the samples.

- transistor multiplier (sampler)

MOSFET
Enchancment



يعمل بجهد
موجب عند البوابة



y(t) = pulses genration

نوع التضخيم عكسي
نوع الدائرة common collecter

b- how to restruct or diffiction the orignal signal ?

تقنية استرجاع الاشارة الاصلية

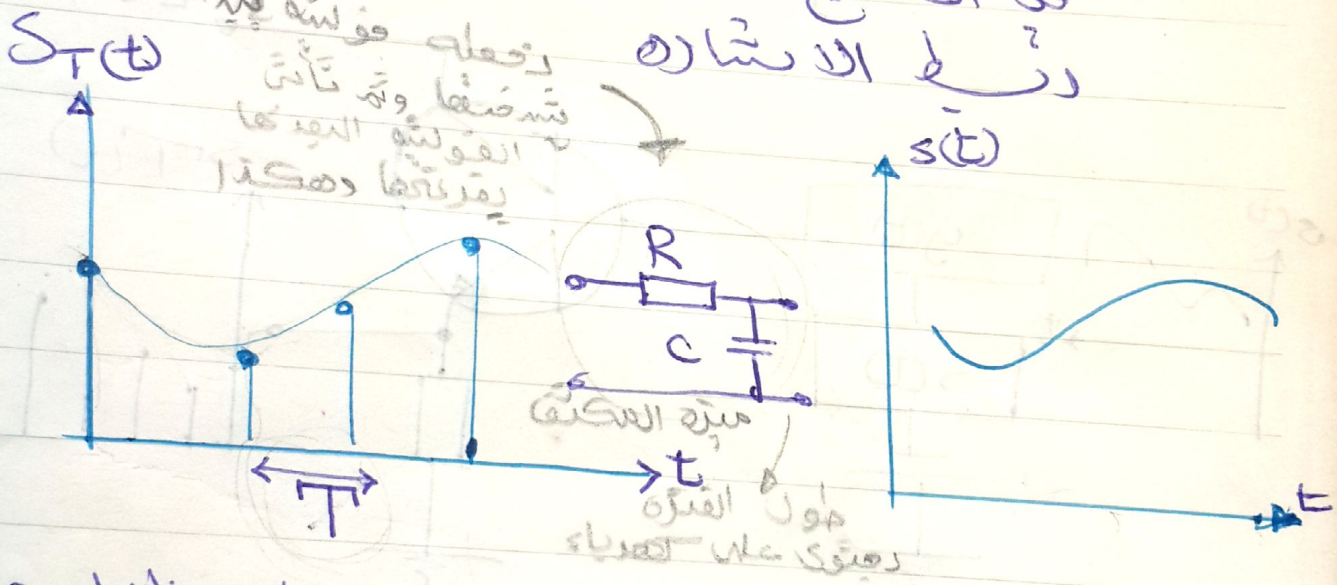
Low Pass Filter OR Integration

عملية دمج الموجات مع بعضها البعض للحصول على إشارة جديدة الأصلية

الـ plus عندما يشحن المكثف ويفرغ dischargeوعند الزمن بين الجهتين

في الخرج لذلك الـ capacitor

دمج الإشارة



- Integrator دمج الإشارة
- Low Pass الإشارة تتكون من عدة ترددات ويمر أقل تردد يفعل الإشارة الأصلية

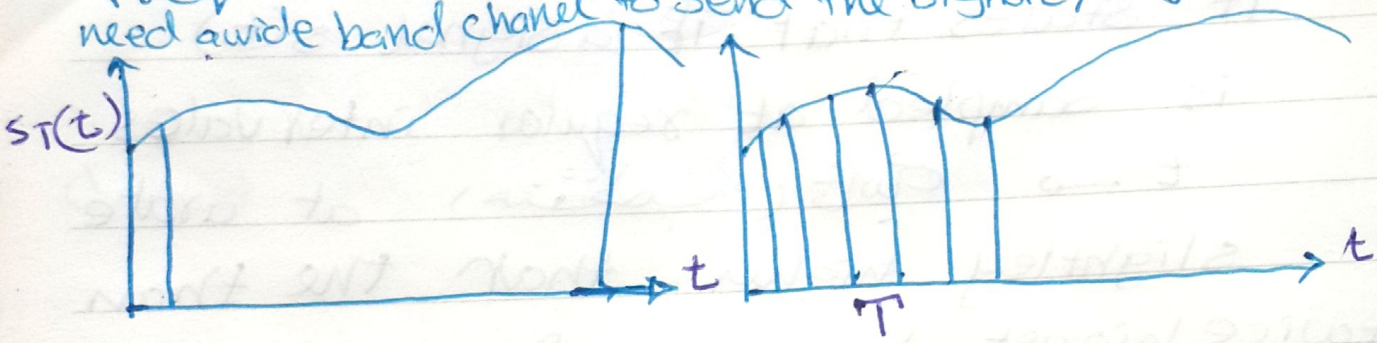
what is the length of the Period (T)?

إذا زدنا T إلى ∞ يستطيع إرجاع الإشارة

If T is long the orignal signal can not be restruct

very high Freq ← T وبالتالي نحاول نقلل الـ

need a wide band chanel to send the signal, high cost.



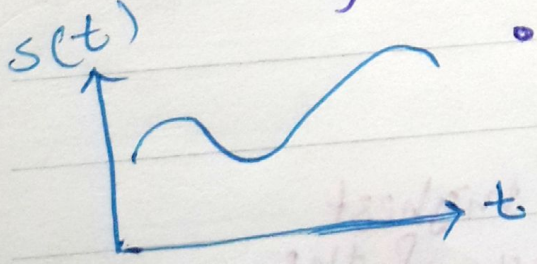
لذلك لابد من عمل مقارنة من اختيار T كبيرة او قليلة حتى نتمكن من استرجاع الاشارة الاصلية وبتكلفة عالية.

compromise between two

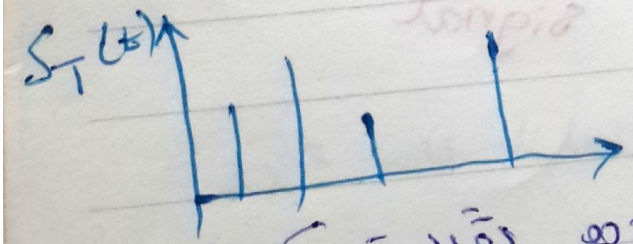
what is the optimum T ? مثالية

sampling principle مبدأ أخذ العينات

nyquest principle



- the sampling Principle specifies the least number of samples of a signal for its compelete difinition



* nyquist قاعدة تحدد أو تقارب اقل عدد من العينات لتطبيق الاشارة بشكل كامل

في كل cycle لابد من وجود ٢ على الأقل
2 sample

فاهي نقطة المطابقة وعدد مستقلة تأتي أقل عدد وأوضح

It states that if a signal s(t) is sampled at regular intervales t → ثابتة (منتظمة) at a rate slightley higher than the than twice higest frequeny of the signal Then, These samples contain all the information of the signal

لو حطنا أكثر العينات بسرعة أكبر بقليل أكبر من ضعف أعلى اشارة
في هذه الحالة نتحصل على اشارة تحتوي كل المعلومات.

$$R_s \geq 2 f_m$$

R_s = f_s → the sampling rate sampel/sec

f_m → the highest freq of the signal

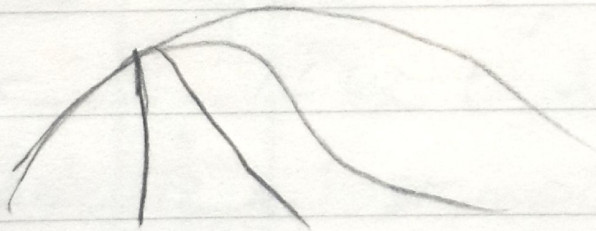
f_s = عدد الـ samples في الثانية الواحدة sps

* تردد التلفون 3400 Hz

* الاتحاد الدولي للاتصالات زاد التردد Rs
8000 بدل 6800

ITU regurlation

* كلما زاد عدد البيانات كان افضل

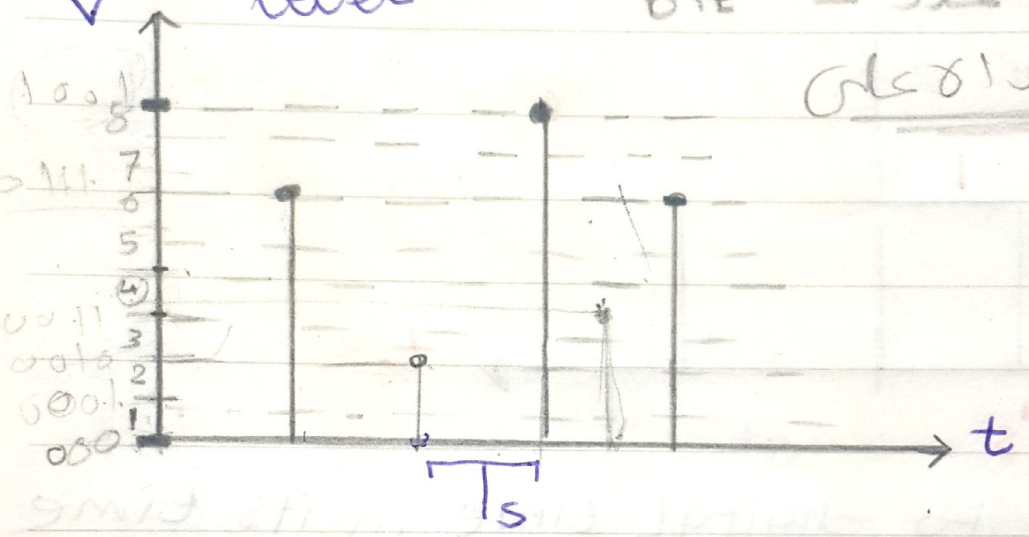


محاضرة ٤

* Quantization :-

* to divid the signal into number of levels
Approximation each sample to a given number of levels (volt).
to magor each sample and to record

① اولاً نحدد عدد الـ bit ثم نقدار على



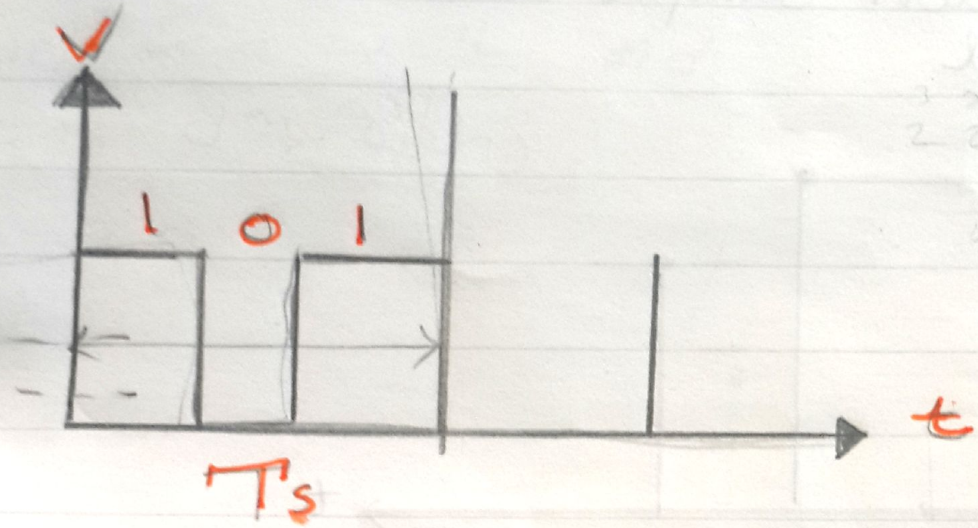
أي عينة تتمثل إلى مستوى حتى يتم coding لكل عينة

* num of levels :-
2, 4, 8, 16, 32, 64, ---, 256

N : the num of levels
we can convert the sample into a digital word
the process after

PCM : Puls code modulation

يبدل ان تحول هذه العينة قيمتها 5v
نعطيها code مثال 101



convert to digital time in its time
ويجب ان تكون في نفس قيمتها
each word have its length or
have agiven number it call bits

If the number of bit is Three
we will divide it 101

* the number of bit depend on
the number of level مهمة ضرورية

1 volt → 3bit
100 " → 200 bit
مثال

num of levels ← $N = 2^n$ → num of bits

binary

bits عدد ← $\log_2 128$ ← levels عدد

7 ← 128

1 → 1

what is the relation between the sampling rate (R_s) and bit rate (R_b)

$R_s \times n = R_b$

$8000 \times 8 = 64$ bits/sec

If the number of level of our the telephone signal is 256 claculte the number of bits (bit rate of asignal)?

bit rate: number of bit/sec

$n = 8$

$R_b = 64$ bit /sec

8 bit ← 125 ns

$= \frac{125}{8}$ M sec

$T_s = 125$ M s

$R_{sxn} = R_b$

$f_s = \frac{R}{n}$

$R \& f_s \log_2(N)$

$T_b = 125/8$

$\frac{1}{\frac{125}{8}} = 8 * \frac{8 \times 10^6}{125 * 8} = 64\ kbit/sec$

$\frac{1}{\text{الزمن}}$ = التردد (bit rate) r_b

Sampling rate = 8000

$\frac{1}{8000}$ sec = 125 Msec = المسافة

R_b تقسم على 8 حالات وثانية

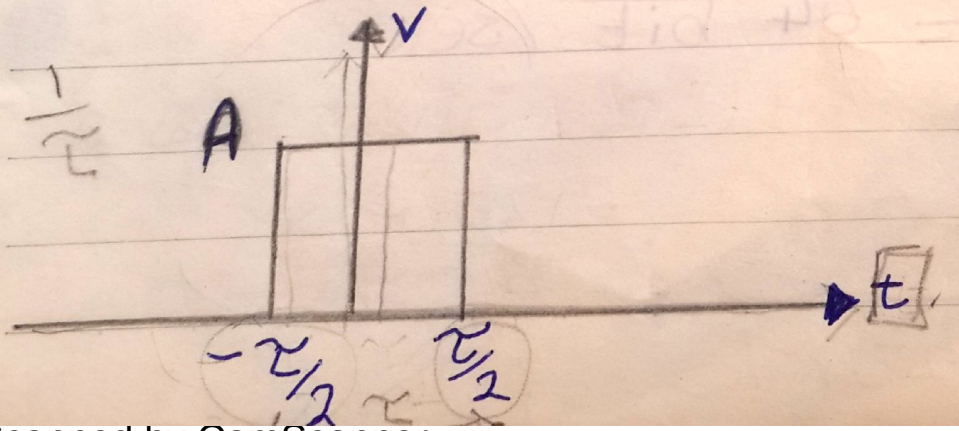
* $R_s = \frac{1}{T_s}$, $R_b = \frac{1}{T_b}$

$256 = 2^n \rightarrow n = 8$ bits

RB = Baud rate → simple/sec
Symbol

the num of symbol changes

* Band width of a pulse *



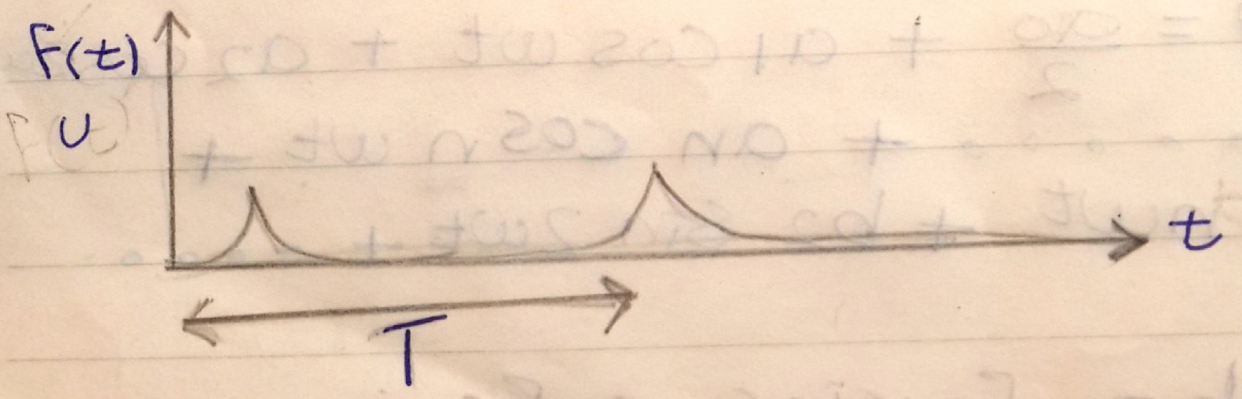
the digital signal its apulse
we try to find the width
of this pulse.
the digital signal have
very wide band width

what is the Forier Series ?
what is the Forrier Trasform ?

* Fs :-

If we have aperiodic signal
this signal can be expended
into a number of orthogonal
signals.

اذا كان لدينا اشارة دورية فإنه
يمكن تحويلها الى اشارات متعامدة
(dot Product = zero)



* الاشارات المتعامدة :-

$(\sin x , \cos x , e^{\pm jx})$

$\phi_1(t), \phi_2(t), \phi_3(t), \dots, \phi_n(t)$

- تكون هذه الدوال متعامدة اذا كانت ال Dot Product (ضرب العددي) Zero

Orth if

تعريف ال orth

$$\int_t \phi_i(t)\ \phi_j(t) = \begin{cases} 0 & \text{if } i \neq j \\ K & \text{if } i = j \end{cases}$$

orthognaloty نظرية

Par seval

$\int \sin x * \cos x = \text{zero}$

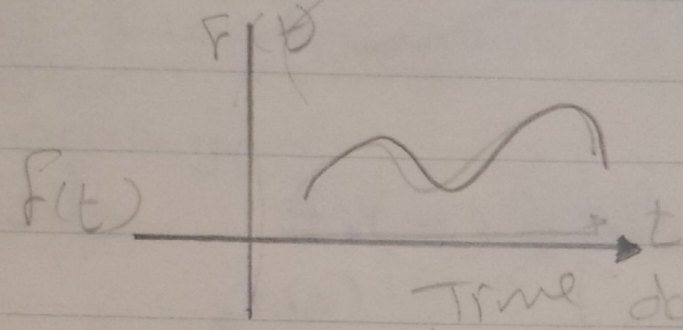
* نظرية Fourer :-

$$f(t) = \frac{a_0}{2} + a_1 \cos \omega t + a_2 \cos 2\omega t + \dots + a_n \cos n\omega t + b_1 \sin \omega t + b_2 \sin 2\omega t + \dots$$

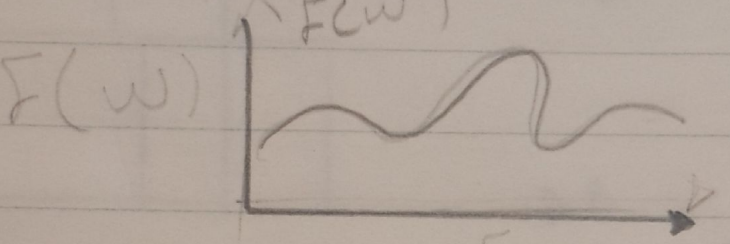
a, b = Forier cofisionce

F. series :-

$$f(t) = \frac{a_0}{2} + \sum a_n \cos n\omega t + b_n \sin n\omega t$$



Time domain reprentiaion of signal



Frequen domain

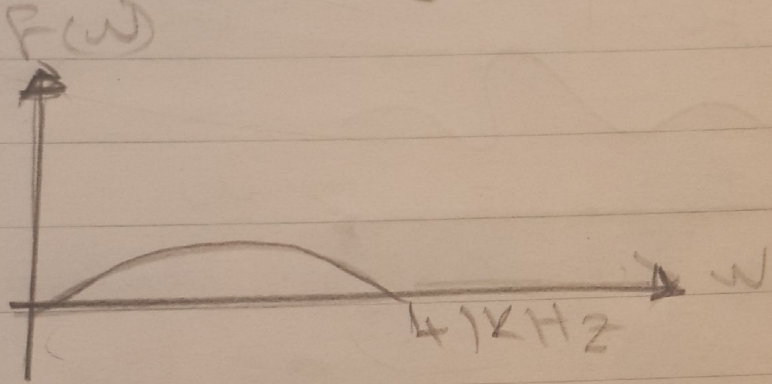
اي دالة او اشارة اذا كانت دوريه يمكن
ان تكون ممثلة من اة اشارات
بالترددات = ... و 2w, w
w ← Frequency

F.T ← w = zero

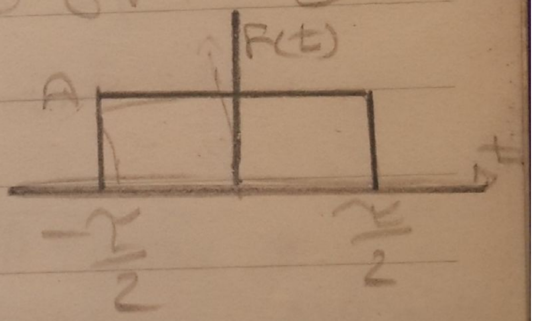
Freq domain من الاشارة
يعني الترددات = الموجودة
في اة اشارة
ع الاقل من 4KHz

وحتى نعمل sampling زمني ان لا نكون
التردد اكثر من 4KHz الذي
عرفناه لمعلومية F-T

$$F(\omega) = \int f(t) \cdot e^{-j\omega t} \, dt$$



وكل ذلك استطيع معرفة الـ Bandwidth
of apulse depend on τ



$\tau =$ ارتفاعه A وعرضه

$$F(\omega) = \int_{-\tau/2}^{\tau/2} A \, e^{-j\omega t}$$

defent integration

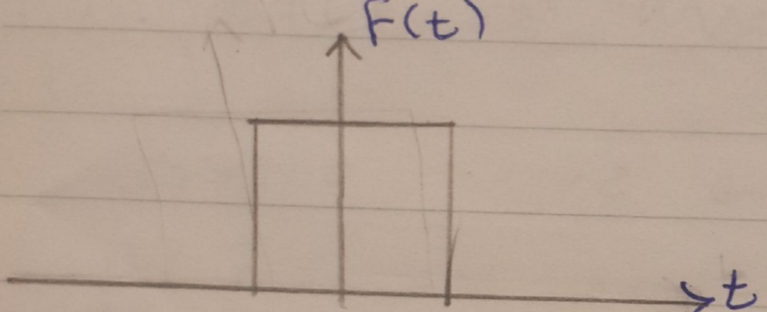
$\frac{0}{0} = 1$ ← هنا

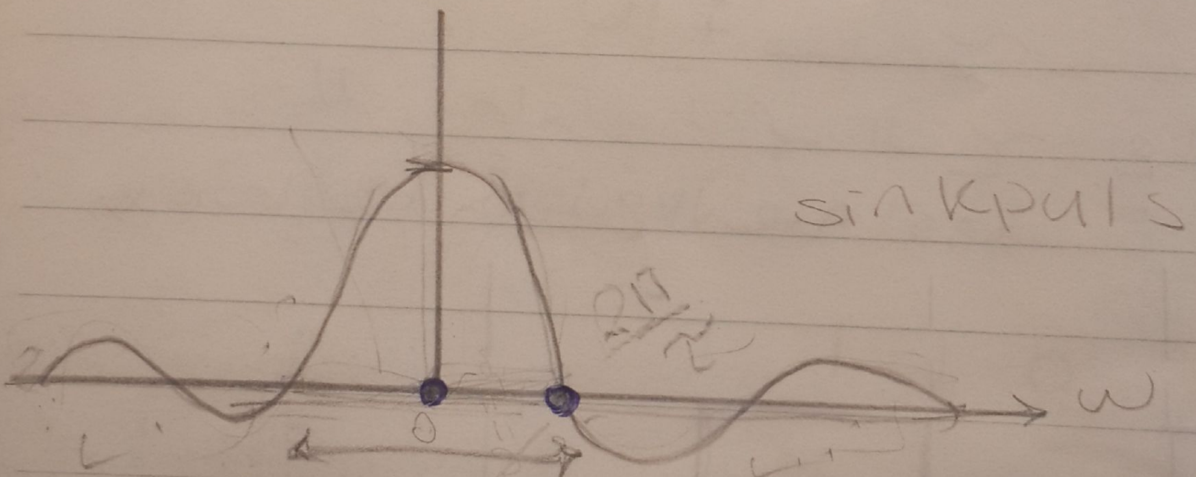
بعد التكامل

$$F(\omega) = A\tau \frac{\sin \omega \frac{\tau}{2}}{\omega \frac{\tau}{2}}$$

اذا رسمنا الـ curve نعطينا band width of puls

sink puls →





تأخذ النطاق من هذه النقطة

the maxium of F(ω) when ω = zero

$\sin \pi = zero$ → $\omega \frac{\tau}{2} = \pi$

$\frac{\sin x}{x}$ ← sinc function

FFT

bandwidth → $\omega = \frac{2\pi}{\tau}$

ونتجاهل الـ side low لانها صغيره

هل تعطي العلاقة التحدد dimnation ؟

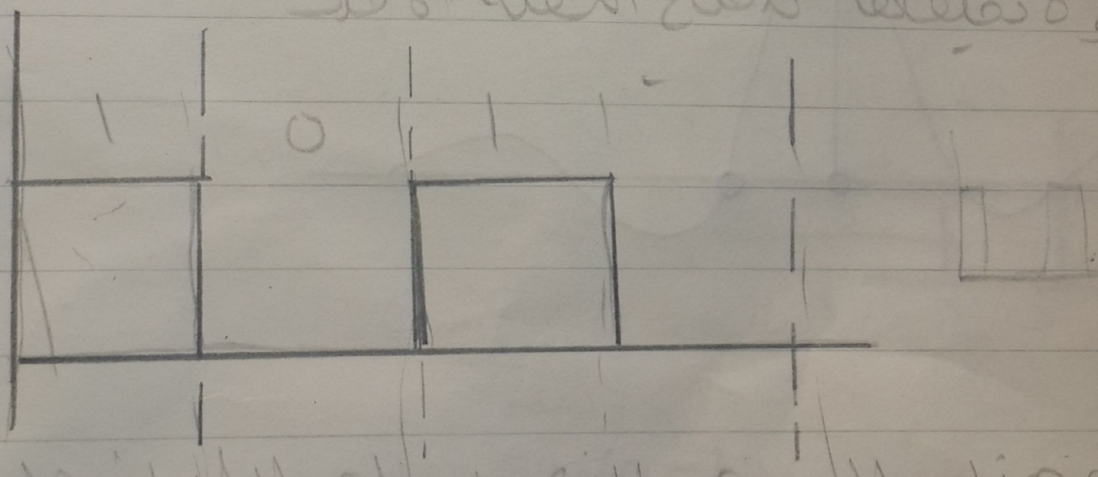
* $F(\omega) = 0 \rightarrow \sin = zero$

*

$-\tau \rightarrow +\omega$

لذلك نحاول نكبر الـ τ في الـ [illegible]

ولا نقللها تفلطح النبضه او تمتد



وهذا اللي الذي يحط الـ digital signals مثلا صغيرة

واذا زدت الـ τ عن كذا الـ

يحدث interference

$$Bw = \frac{1}{\tau}$$

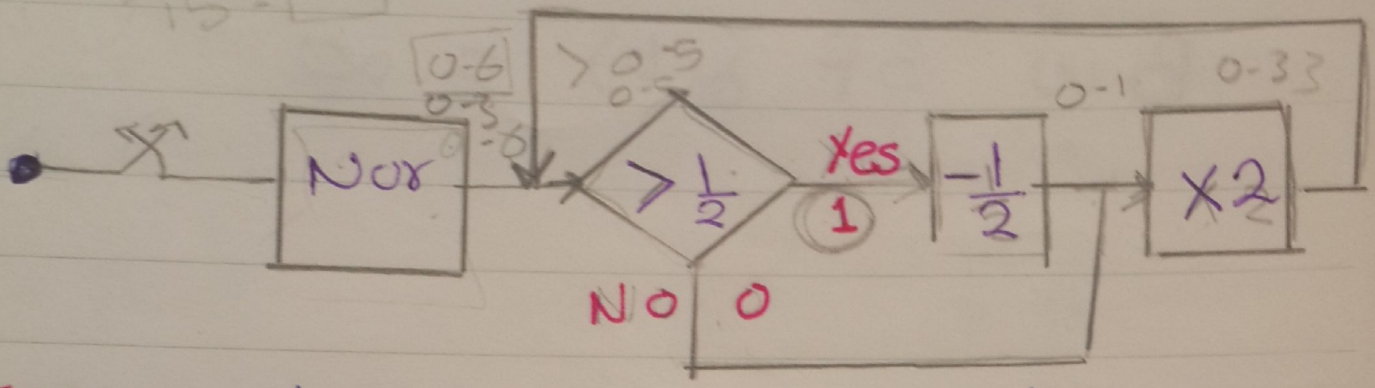
$Bw \longrightarrow \infty$ when $\tau = 0$

العرض

Bw of $\delta(t) = \infty$

Coding (Example)

*Serial Encoder :-



*Normalizing means dividing by the max level

e.g 10V, 3V, 5V, --- 15V levels

Each sample to divid by 15.

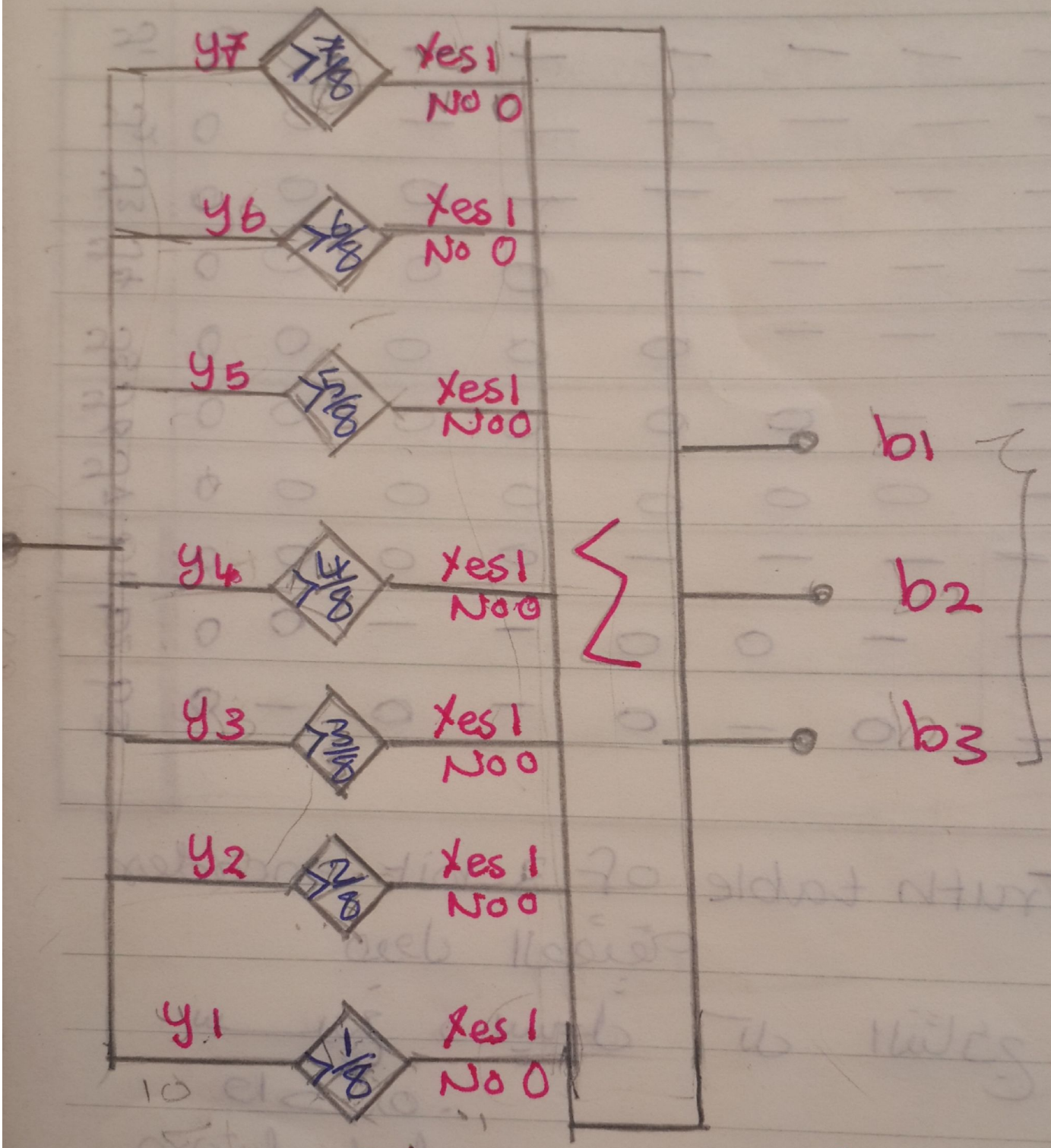
the number of the bits at the output depend on the number of level.

Nor:- Normalizing → maximum of level's equal 1

$> \frac{1}{2}$: comparator record one or each number zero

$-\frac{1}{2}$: subtractor

maxiam, num of bit



3 bit- encoder

Parrel

y_1	y_2	y_3	y_4	y_5	y_6	y_7	b_1	b_2	b_3
0	0	0	0	0	0	0	0	0	0
—	0	0	0	0	0	0	0	0	1
—	—	0	0	0	0	0	0	1	0
—	—	—	0	0	0	0	0	1	1
—	—	—	—	0	0	0	1	0	0
—	—	—	—	—	0	0	1	0	1
—	—	—	—	—	—	0	1	1	0
—	—	—	—	—	—	—	1	1	1

Truth table of 3-bit encoder

جدول الحقيقة

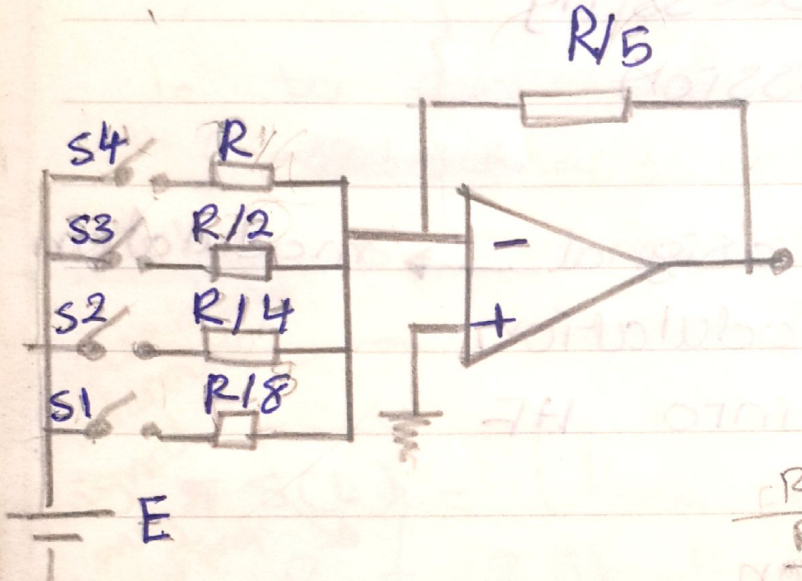
سريع و يسجل كل النتائج في لقطة واحدة.

pulse code modulation

متوازي تقابلي ← $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \dots$

DAC

An Example of 4bit Decoder Detector reconstructor



$V_{O1} = -\frac{R_F}{R_1} \text{ or } \frac{-R/5}{R} = \frac{-1}{5}$

$\frac{-1}{5} \times E = E/5$

$\frac{R/5}{R \times R/2} = \frac{0.2R}{0.5R^2} = \frac{1}{5} \times \frac{2}{3R} = \frac{3}{5}E$

$\frac{3}{2}R$

the pluses are applied through this switches

switch → ON → 1

switch → OFF → 0

S1	S2	S3	S4	O/P
0	0	0	0	0
0	0	0	1	E/5
0	0	1	0	2E/5
0	0	1	1	3E/5
0	1	0	0	4E/5
0	1	0	1	8E/5
0	1	1	0	15E/5

EXG = OUT

G = $\frac{R_F}{R_{in}}$

LPF → signal

1- Signal Processing
2- Transmission

لإرسالها لابد من عمل mod

* to transmit asignal → modulation

What is modulation
1- Conversion into HF
2- Carrying
3- Modulation

we want to trasmit our msg we first convert signal into digital (take sample ,,,,,,)

بعد تحويل الإشارة إلى digital العملية التالية هي Transmission

to transmit the signal, or the information or the base band it's reltively alow frequency If we transmitted directly it will be affected by interferance or distortion or attenuation, ---

Scanned by CamScanner

* كلما زاد التردد لزيادة الطاقة وبالتالي لتوصيلها أبعد

The First step befor transmission

1. to converted into high frequency domain

what is mean by high Frequency domain?

Base band Information Signal msg Low freq

* $S(t) = U_\Omega \cos \Omega t$ ← تردد زاوي

$\Omega = 2\pi f_\Omega$ $\frac{1}{T}$

wave Carrier High freq

* $U = U_0 \cos \omega t$ $\omega = 2\pi f$

Sampling Time

modulation:-

The Process carring the low Frequency (signal) by high frequency (wave)

changing the Parameter of the high Freq by the low Freq

تحويل المعلومة الى كمية كهربائية لتفادي مشاكل الارسال ولذلك لابد من تحويلها الى نطاق الترددات العالية (حمل المعلومة بواسطة التردد العالي ـ التعديل)

يتم تغيير تردد الموجة الحاملة طبقاً لاتساع الاشارة Amp على حسب الاشارة

التعديل: التغيير في أحد مدخلات الاشارة الحاملة (العالية التردد) بواسطة الرسالة المحمولة

$$u = U_0 \cos\Phi$$

$$u = U_0 \cos(\omega t + \theta)$$

U_0: Amplitude — ω: angular Freq — θ: phase — $t=0$

التغيير في أحد اضلاع الاشارة عن طريق تسمى modulation

we have three types of modulation:-

1- Amplitude modulation تعديل السعة

2- Frequency modulation التردد =

3- Phase modulation الطور =

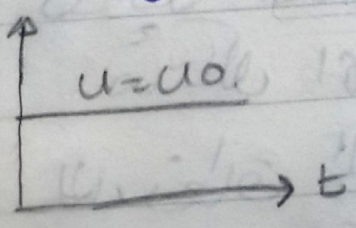
vartion of the Amp / Frey / phase of the wave by signal

تعديل سعة الموجة الحاملة بواسطة الاشارة

* **Amplitude modulation:-**

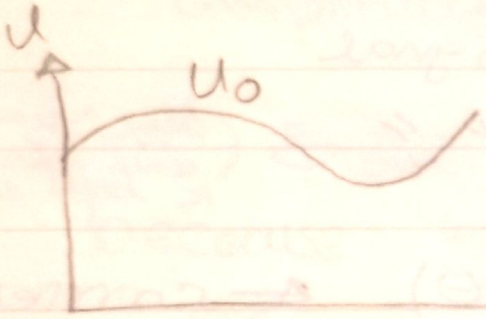
new U_0

$$U = U_0 + U_{-\Omega} \cos -\Omega t$$



signal الـ Carrier الـ Amp هنا

maxium cos = ± 1



U_0 تغيرت واصبحت

$u = U_0 + U_\Omega \cos \Omega t$

new Amplitude

but we are transmiting digital signal not anlag signal

digital signal's have only two level crosponding to 0 or 1

t على تعتمد

لذلك جميع المعادلات الجديدة

$u = U_0 \pm U_\Omega$

$u = U_0 \left(1 \pm \frac{U_\Omega}{U_0}\right)$

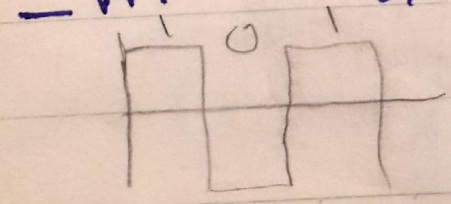
The Process Call digital Amplitude modulation (because we have only 2 amp)

$u = U_0 (1 \pm m)$

$m \equiv$ modulation index

$+m$ when transmiting 1.

$-m$ " 0.



على حسب الـ code

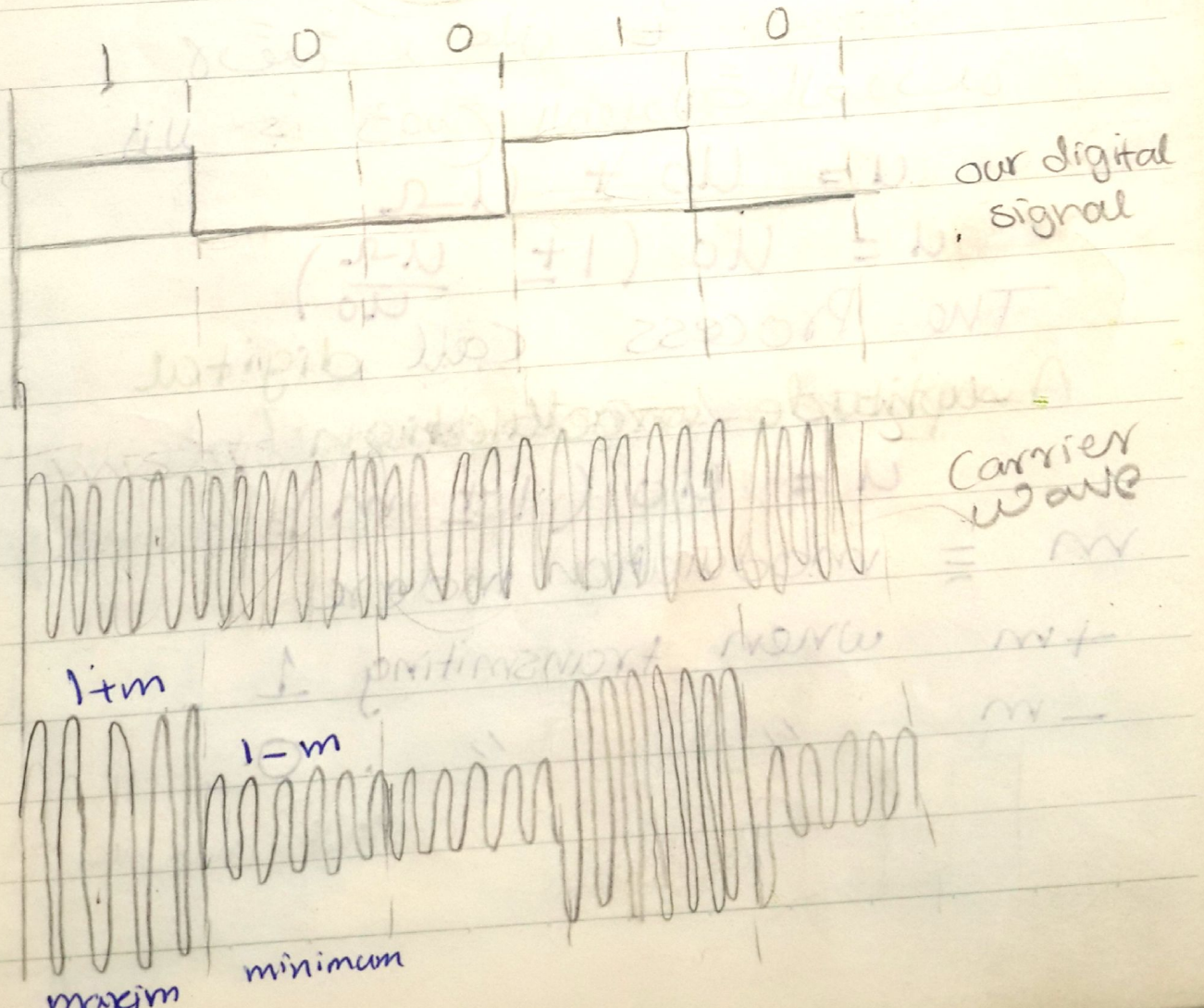
U_Ω = the level of signal
the amplitude " "

$u = U_0 \cos(\omega t + \theta)$ ← carrier

$U_{max} = U_0 (1+m)$
$U_{min} = U_0 (1-m)$
} depend on the level of the pulse

given → 2 Level (0, 1)

FSK



It is also called amplitude shift keying ASK
(Lec 5)

(تغيير بين سعه لأخرى اعتمادا على الـ 0,1 level) الإنتقال بإزاحة السعة
because the amplitude shift from one to other

Am = product modulation

m = 1 → full modulation
حتى تكون الـ اشارة واضحة (الطاقة - الصوت واحد)

قدرة الارسال كاملة ← 1500 KW

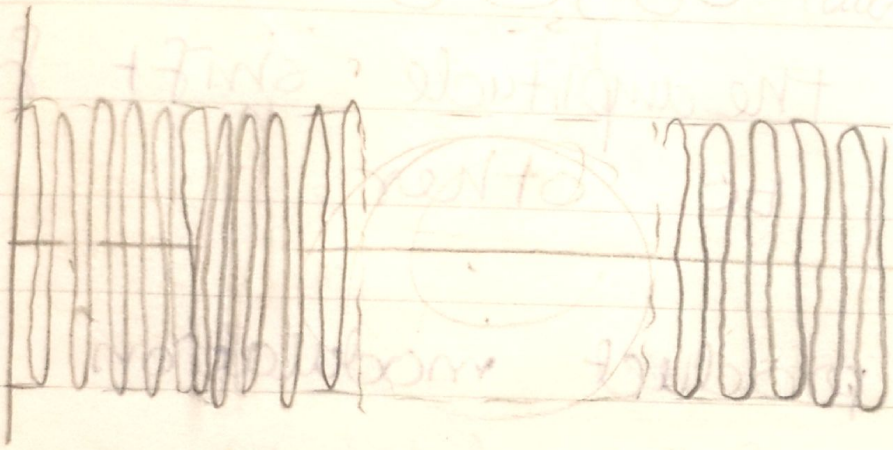
→ $P = P_o(1 + \frac{m^2}{2})$ القدرة بعد التعديل

قدرة الـ carried

m = 1 → القدرة تزيد 1.5
m = ↓ → تنخفض مرتين //
Fm → اذا زاد الصوت او انخفض لا يتأثر
استهلاك التيار عكس الـ Am
m < 1 → يتغير شكل الاشارة
0.95 → effective

m = 1 →
— $U_{max} = U_o(1+1) = 2U_o$
— $U_{min} = U_o(1-1) = \text{zero}$

in the case the input signal zero the result as shown in Fegure



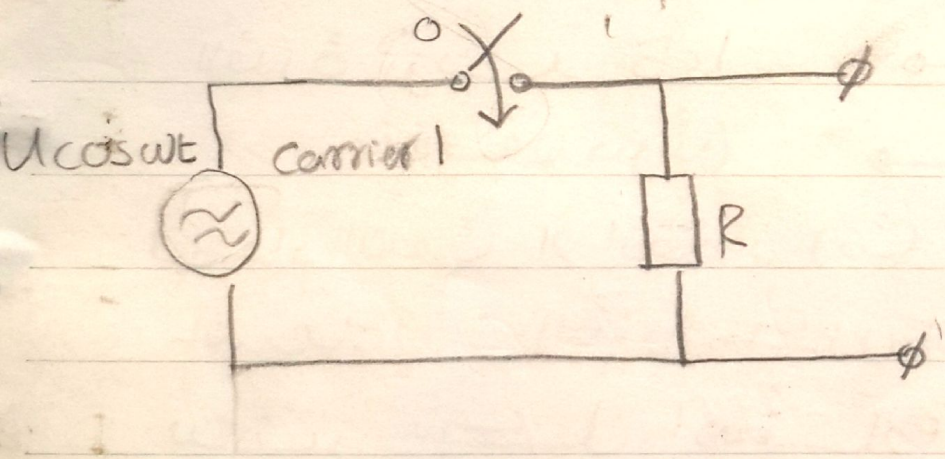
ASK

$m=1$ → OOK

ONgoff oraw Keying

asimple ~~Am~~ modulatorg

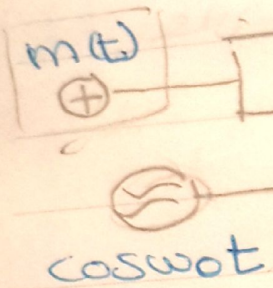
OOK



ASK $m=1$ → OOK

Lec 5

ASK modulator (ON OF Keying) :-



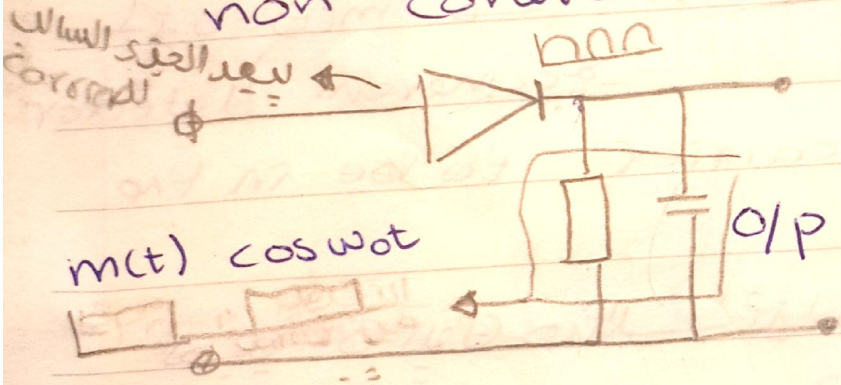
$o/p = m(t) \cos \omega_0 t$

$m(t) = 1 \text{ or } 0$

Envelope detector :-

non coherent detection

non linear device



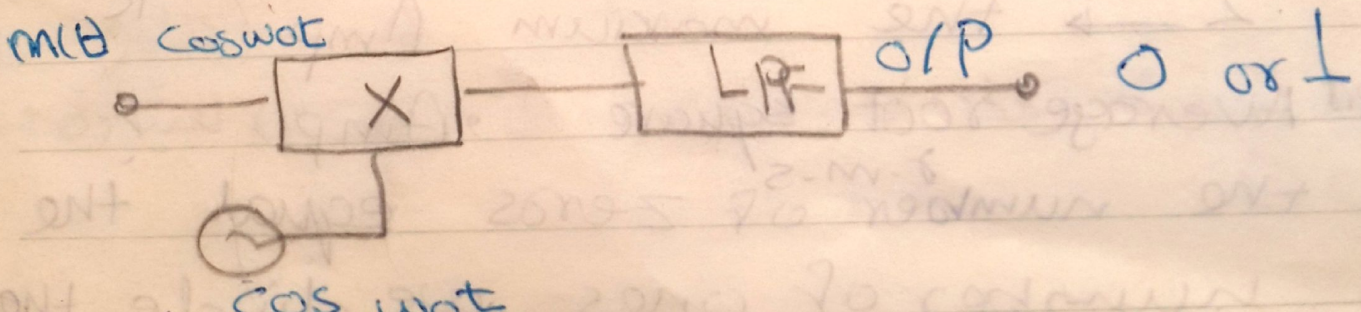
$o/p = C m^2(t) \cos^2 \omega_0 t$

$= \frac{C m^2(t)}{2} (1 + \cos 2\omega_0 t)$

$= C m^2(t)$

$m(t) = m^2(t)$ because it is $= 0, 1$

Coherent Detector :-



↳ local oscillator

$m(t) = 0$ or 1

تشغل $m(t)$ في $\cos w_0 t$ عن طريق ضرب

على الاتجاه $m(t)\cos w_0 t$

charcterstic of diode

Cv^2

high freq نشيل LPF عليه نقدر نشيل الـ cos ⇒

$m^2(t) = m \rightarrow m(t) = 0$ أو 1

- coherent detector

there is a carrier to be in the receiver

يجب ان يكون هنالك تزامن بين الارسال والاستقبال

. synchroustion

discibe the strucure opration of ask detectors ? 3 figures

ASK Power

Carrier → sinsoidal → $P = \frac{a_0^2}{R}$

2 → the maxium Amp $(2a_0)$

diffrent Average root square r.m.s, Amp ?

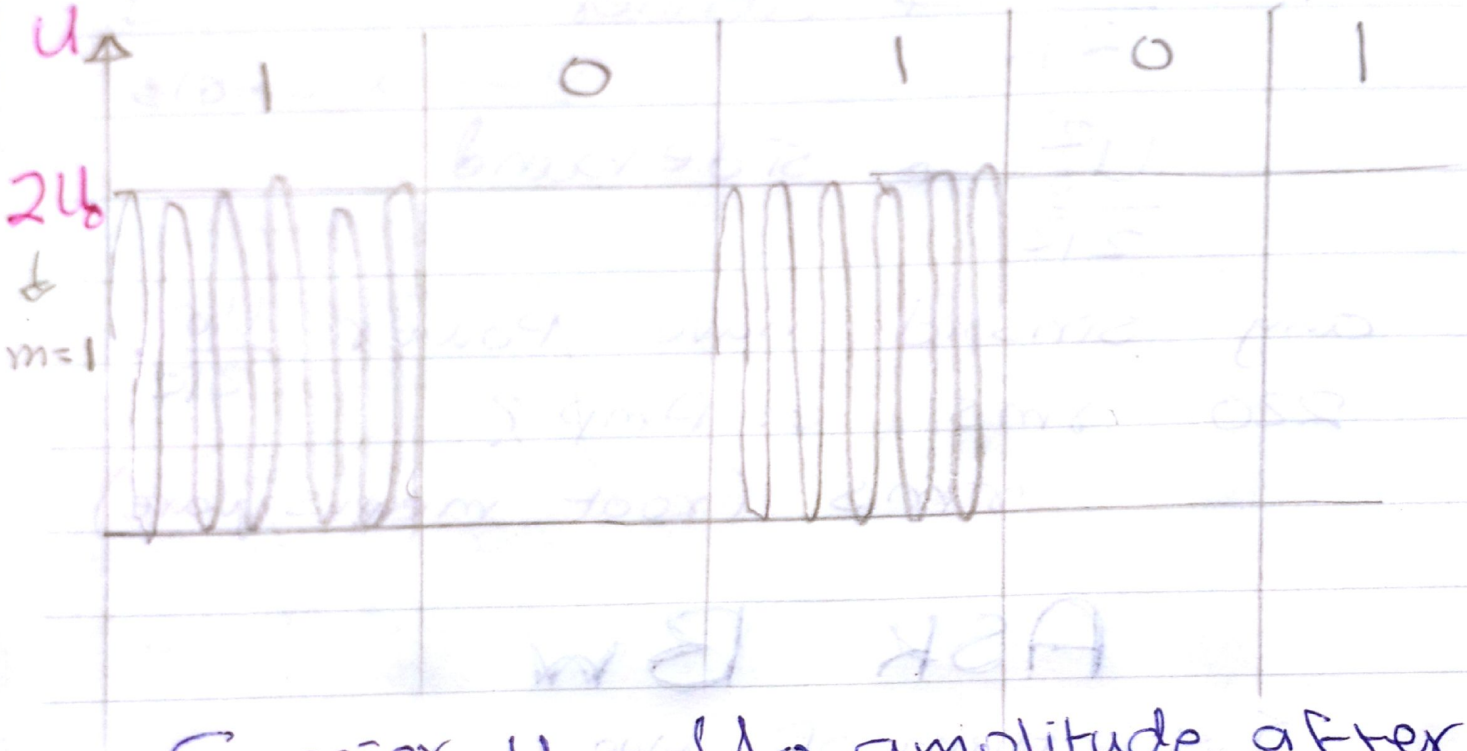
If the number of zeros equal the number of ones we divide the Power by 2 $P_t = a_0^2/R$

$\frac{U_0^2}{R}$ → average Power $\frac{U_0^2}{2R}$

$U = U_0(1 \pm m)$

$U_{max} = 2U_0$ For 100% mod

$U_{min} = $ Zero



Carrier $U = U_0$ amplitude after mod $U = 2U_0$

$$P_C = \frac{U_0^2}{2R}$$

$$P_{total} = \frac{(2U_0)^2}{2R} = \boxed{\frac{2U_0^2}{R}}$$

اذا كانت كل الاشارة 1 يمكن اعتبارها DC

تضاعفة ال Power ال carrier لعبه

ال modulation

بعد القسمة على 2 تجدها اتقسمت Carrier فلك جزء يذهب

$\frac{U_0^2}{2R}$ → Carrier ل

وواحد يذهب

$\frac{U_0^2}{2R}$ → side band

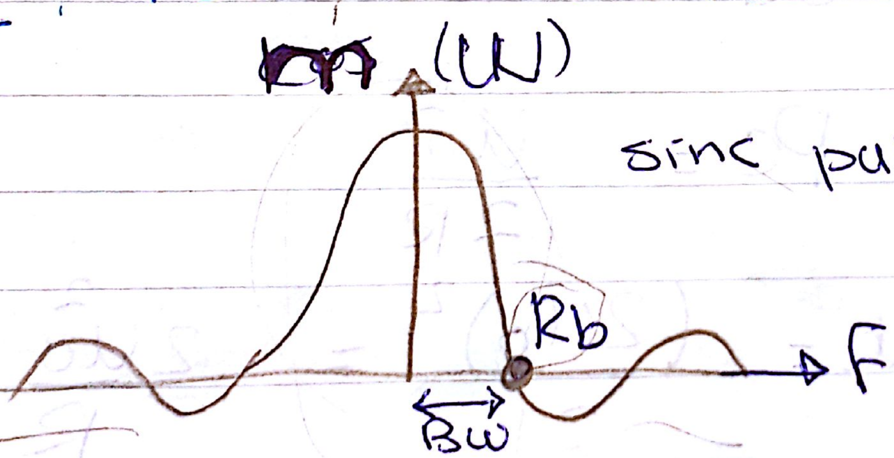
any sinsoid have Power $\frac{U_0^2}{2R}$.

220 rms or Amp ?

rms (root mean square)

* ASK Bw *

{ spectrum of the wave
  Fourier Trasform (التحديد ال Bw)



sinc puls = $\frac{\sin x}{x}$

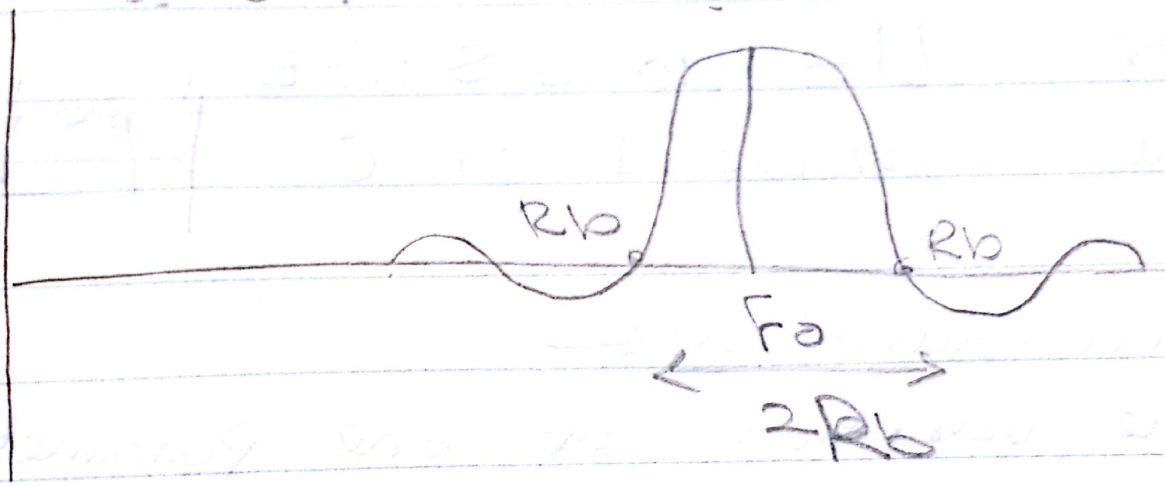
the trasform of the digital signal

tails side

m(t) cos ω₀t

modulation of Fourier Transform

cosωt في الـ TF يجاوز الـ shift



in Am the band width = 2 f_m

" ASK " " = 2Rb

Sem 7 CUJ

Lec6

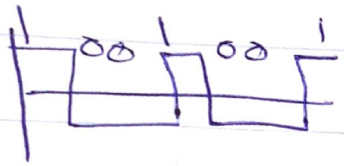
FSK

Frequency shift keying

digital Frequency mod

carrier signal $U = U_0 \cos \omega_0 t$

$m(t) = 1$ or 0



modulating —

the varrtion of one parameter of the carrier in according to the signal.

the carrier shift between 2 Frequency depend on 0, 1

$1 \longrightarrow F_2$ (Fmax)

$0 \longrightarrow F_1$ (Fmin)

$\omega = \omega_0 \pm \Delta\omega$

$\Delta\omega$ → Frequency diviation

$F = F_0 \pm \Delta f$

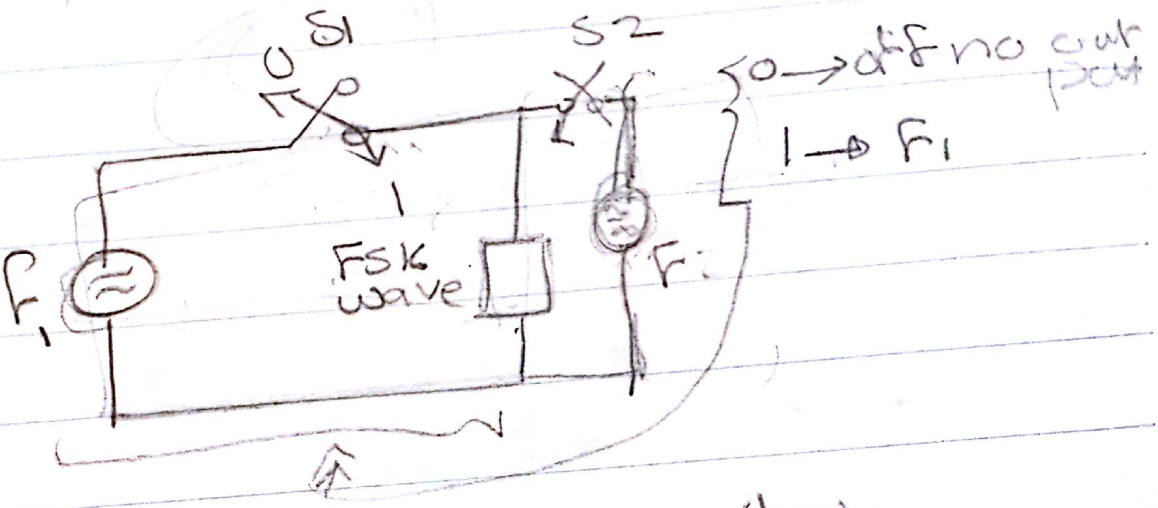
If —

$m(t) = 1 \rightarrow F_0 + \Delta f$

$\omega_0 + \Delta\omega$

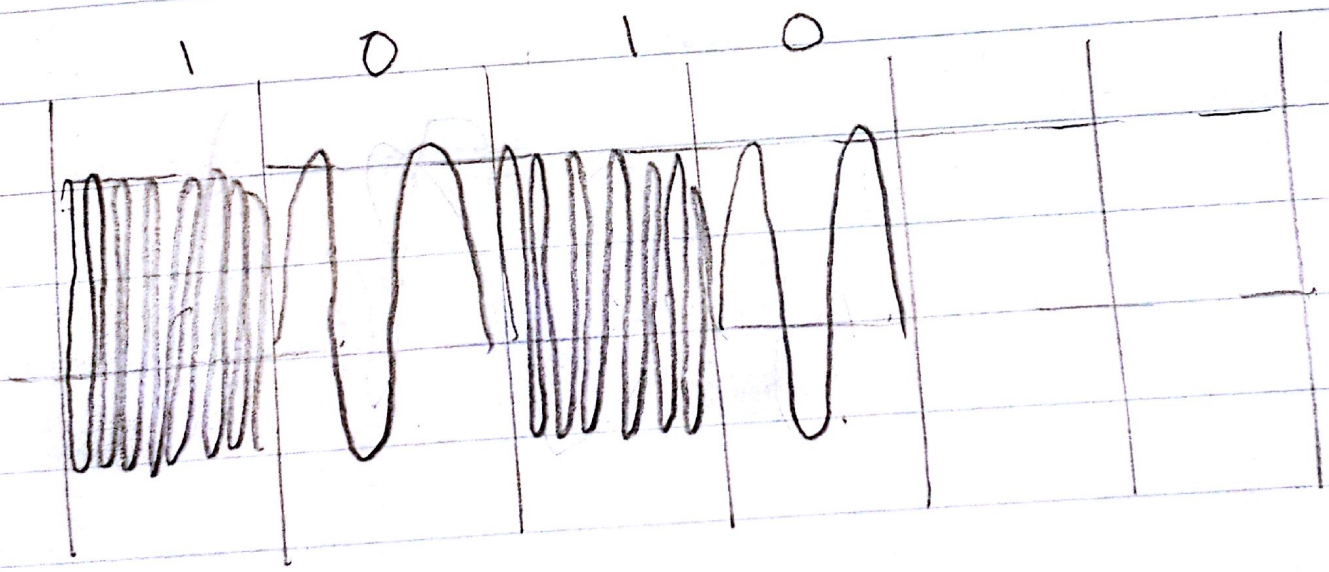
$m(t) = 0 \rightarrow \omega_0 - \Delta\omega$

$\omega_0 - \Delta f$



S1, S2 : change over switch

S1 → on ⇒ S2 → off طلعوس



f_1 → lower Freq

f_2 → high Freq

FSK → 200K

obtain the Band width of a pluse with amplitude 1V and width $\tau = 25\mu s$

$$Bw = \frac{2\pi}{\tau}$$

$$Bw = \frac{2\pi}{25\mu s} = \frac{}{} Hz$$

NO. Lec 6

DATE / /

Tests—

Q1c— A TV signal with bandwidth 0 — 4.5 MHz is sampled using sampling rate 20% higher than the nyquest (sampling Principle rate) and the samples are quantized to 1024 level If the signal is transmitted using Ask find the minmum. Bw required to carry the signal ?

Q2c with diagrams and equations Discuss in detail the genration and detection of ASK?

$$Rs > 2F_{-}\Omega$$

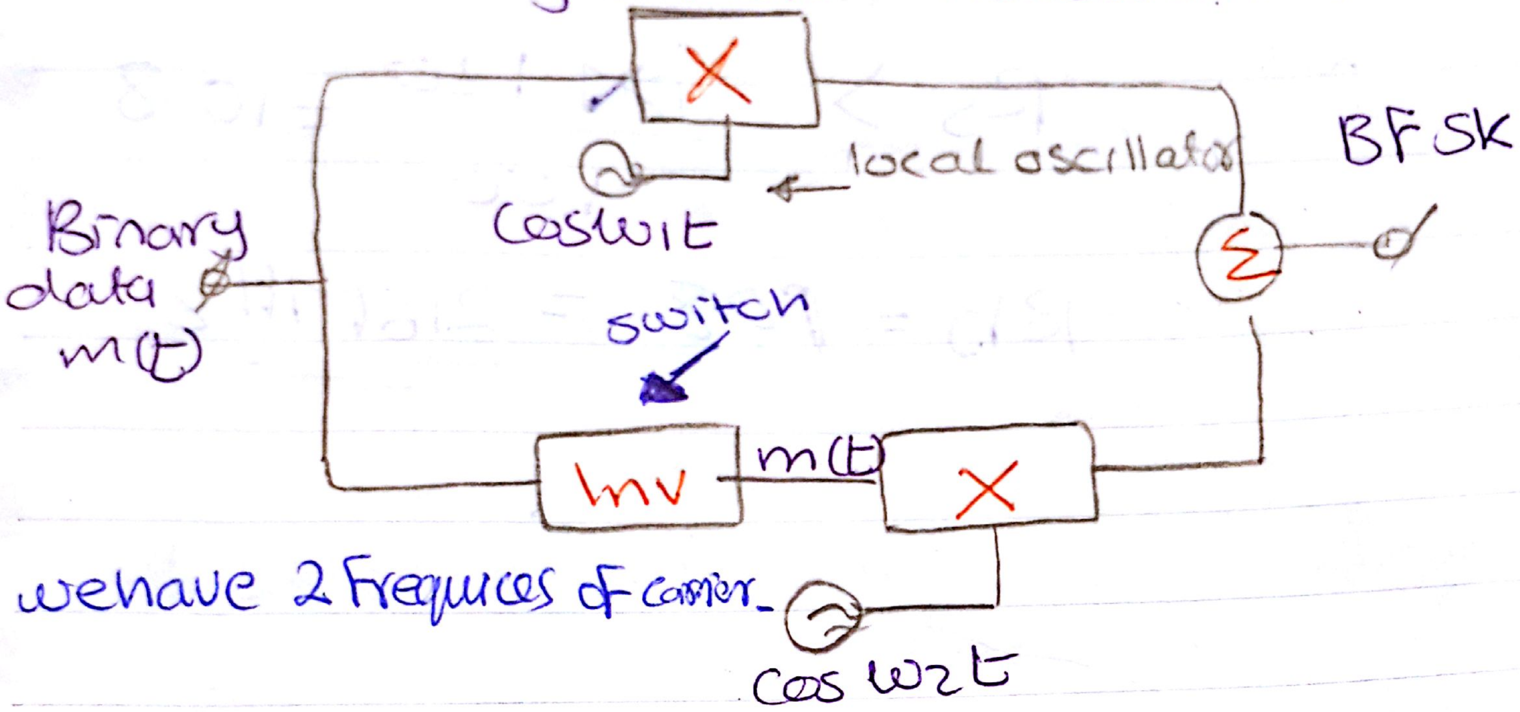
$$Rs > \frac{9 \cancel{X} 120}{100} = 10\text{-}8$$

$$Rb = 108 = 216\,MHz$$

BFSK used in cable & radio communication system.

"7" محاضرة

Binary FSK modulator :-



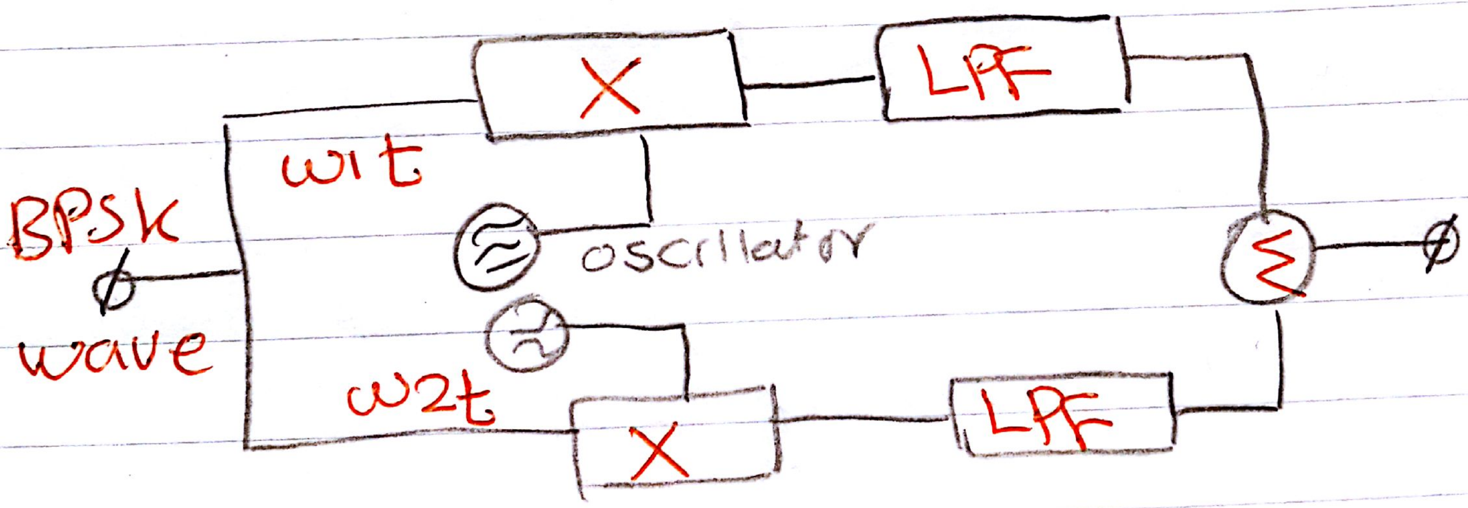
we have 2 Frequices of carrier.

m(t) = 0 OR 1.

$m(t) = 1 \longrightarrow \cos w_1 t$

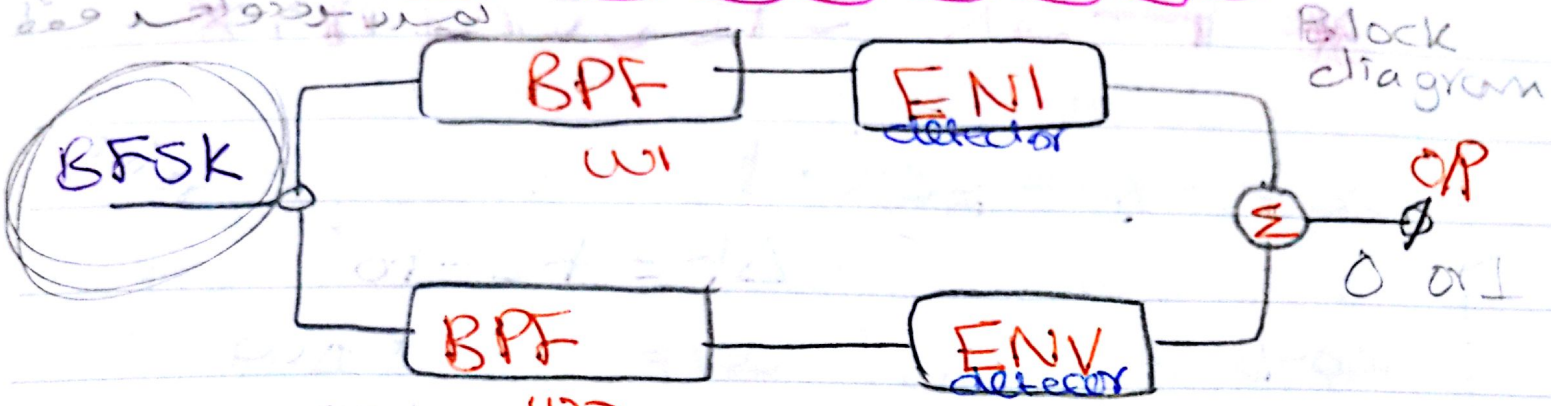
$m(t) = 0 \longrightarrow \cos w_2 t$

Coherent Detector :-



لابد ان يكون هناك senqurezation في الارسال

Envolpe detector



Block diagram

like Amplitude detection

BFSK modulator

$m(t) = 1 \rightarrow \cos \omega t$, INV → zero

$m(t) = 0 \rightarrow$

ω^2 after mod give puls

ENV detector : LPF + دايود

* Fsk Spectrum *

Spectrum of Am x2

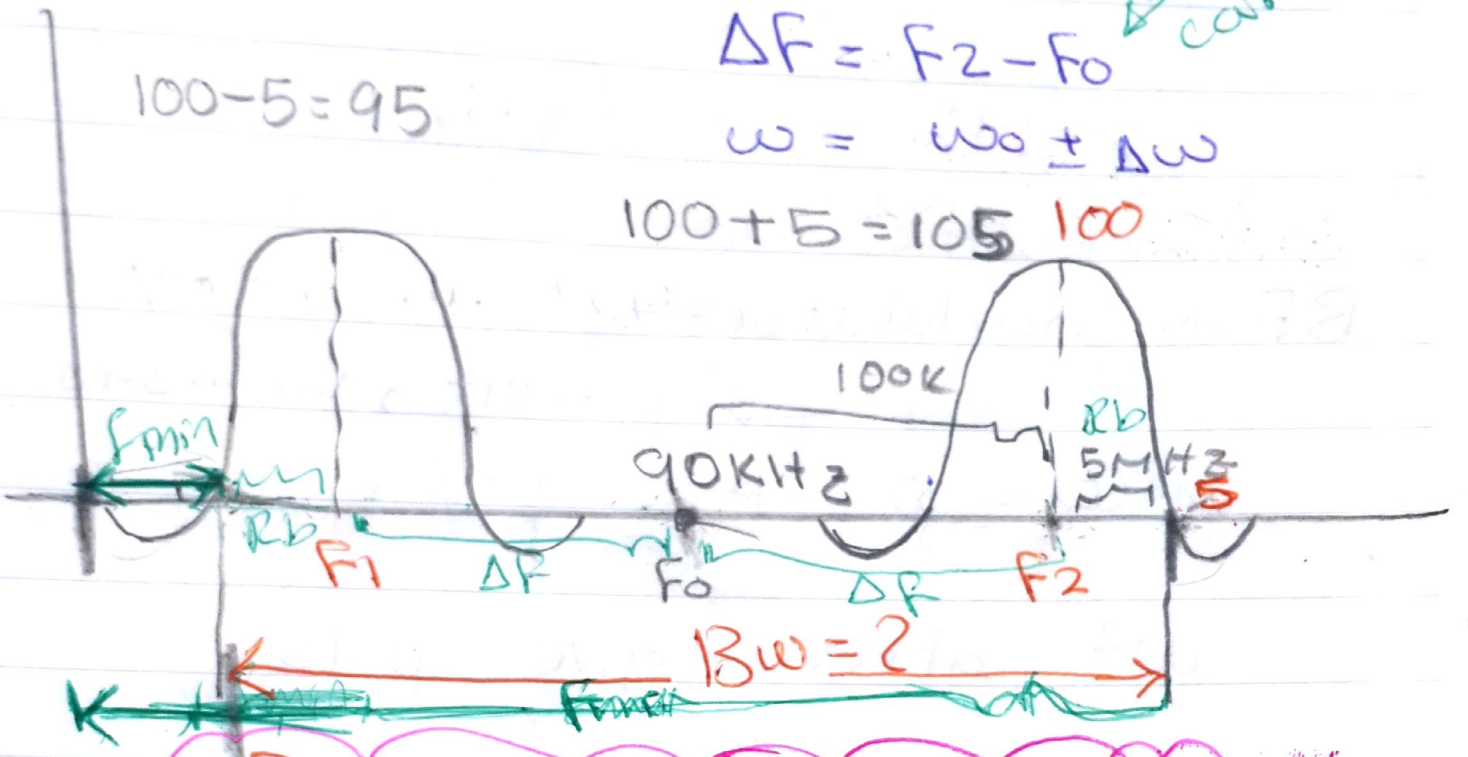
Fsk = OOK

$\Delta F = F_2 - F_o$ ← carrier

$\omega = \omega_o \pm \Delta\omega$

100-5=95

100+5=105 100



$$Bw = 2Rb + 2\Delta f$$

Find the Bandwidth of Fm radio alrabiaa?

Carson's Rules

2Rb

$Bw = 2F_\Omega + 2\Delta f$

$\Delta F = 75$, $F_\Omega = 15KHz$

$Bw = 15x2 + 75x2 = 180\ KHz$

$\Delta f = \frac{f_{max} - f_{min}}{2}$

✱Example :-

If the acarrier of afsk transmistion f_o 90 KHz , Rb = 5M bps Δf the maxium divation 100 KHz

Find the following :-

1- The maxium Frequency at the output = 90 + 5-1 = 95 + 1M Hz

2- The minium = 90 - 5M - 100K = 84.9

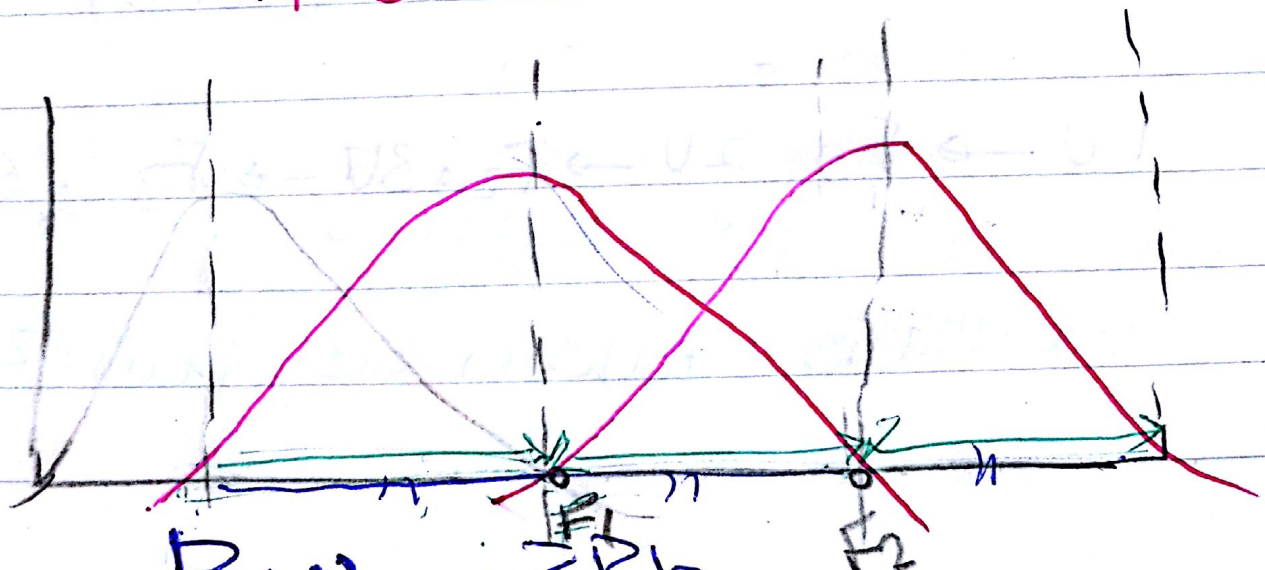
3- The Bw required

SOL :-

Orthogonal BFSK :-

spectrum of OrthBFSK

$Rb = F2 - F1$



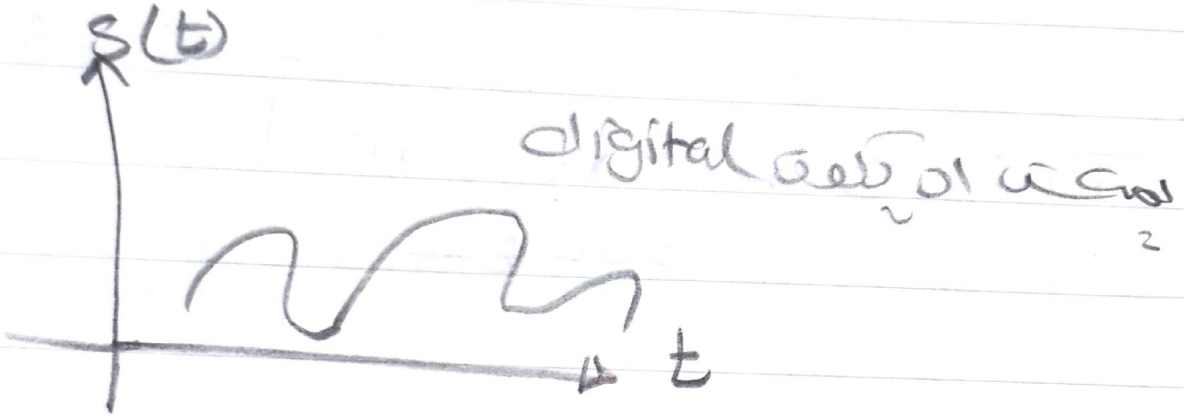
$Bw = 3Rb$

4-ary FSK

4 FSK

It mean that digital signal is not 0, 1

It may have two and more levels.



digital

we have 4 Frequences in the output F_1, F_2, F_3, F_4

Frequency carrier

here we need 4 levels (volts)

1 V → F_1, 2V → F_2, 3V → F_3, 6V → F_4

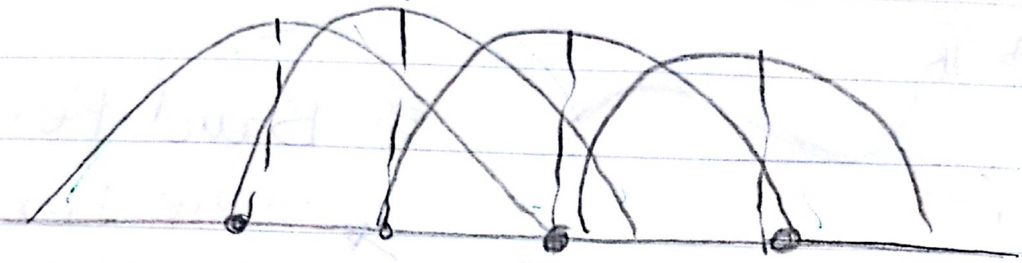
00 ← serial to parallel converter

01

10

Data is taken as pair (2 bits)

Spectrum

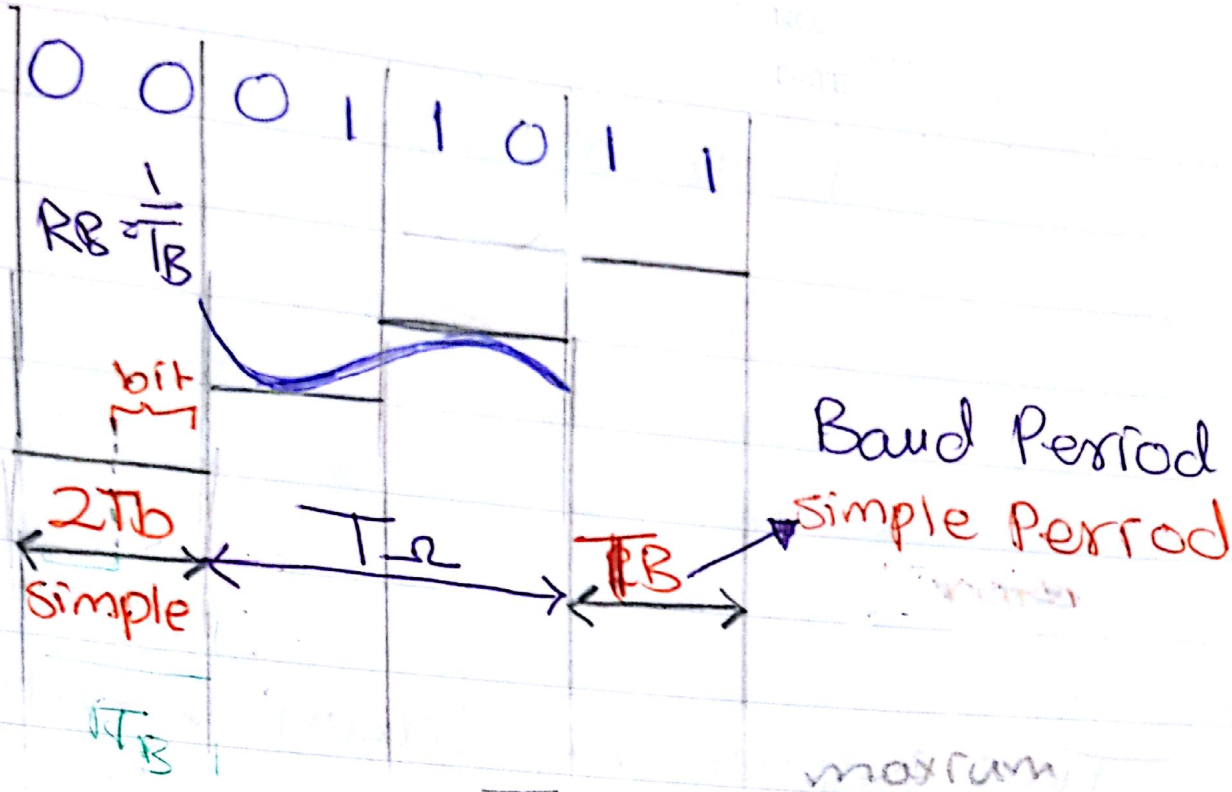


This happen by taken 2bits at the same time to represent a level. and this can be done by using a serial to Parllel converter

2bits enter to modulator as the same time and this two bit have one level.

00	→	level 2ولtage → 0V
01	→	level → 1V
10	→	level → 2V
11	→	level → 3V

بحيث delay بين ال bits حتى يدخلوا ال
mod كل 2bits مع بعض



TB

maxrum

$T_\Omega = 3400$ مرة

لما كان ال Period كبيرة, دقة
التردد قليل ← تقليل المشكلة
الى التشوش

The rate of modulation or simple is called Baud, simple rate.

* $R_B = R_b/2$
* $T_B = 2T_b$

$\frac{1}{T_B} = \frac{1}{2T_B}$

* $2T_b = T_B$

$R_B = \frac{R_b}{2}$

* $R_b = 2R_B$
* $T_\Omega = 4T_b = 2T_B$

analog

$F_\Omega = \frac{1}{T_\Omega}$

$$F_\Omega = \frac{R_b}{4} = \frac{R_B}{2}$$

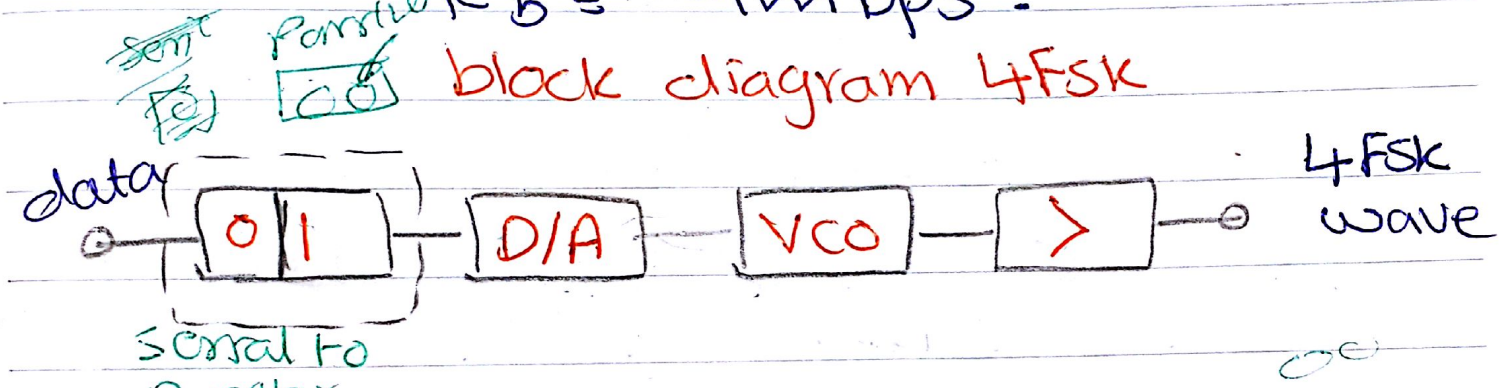
الاشارة تمثل في 2level نقص التطر عند
ان ال level يحتوي على bit .

محاضرة 7

Decribe the structare and aperation of a 4FSK modulator and detection with diagrams show the spectrum diagram and find the Bandwidth If the input data bit Rate

R_b = 9mbps.

block diagram 4FSK



Bit rate = 2* Baud rate

2* simple rate

converto level of voltage each evolt

have

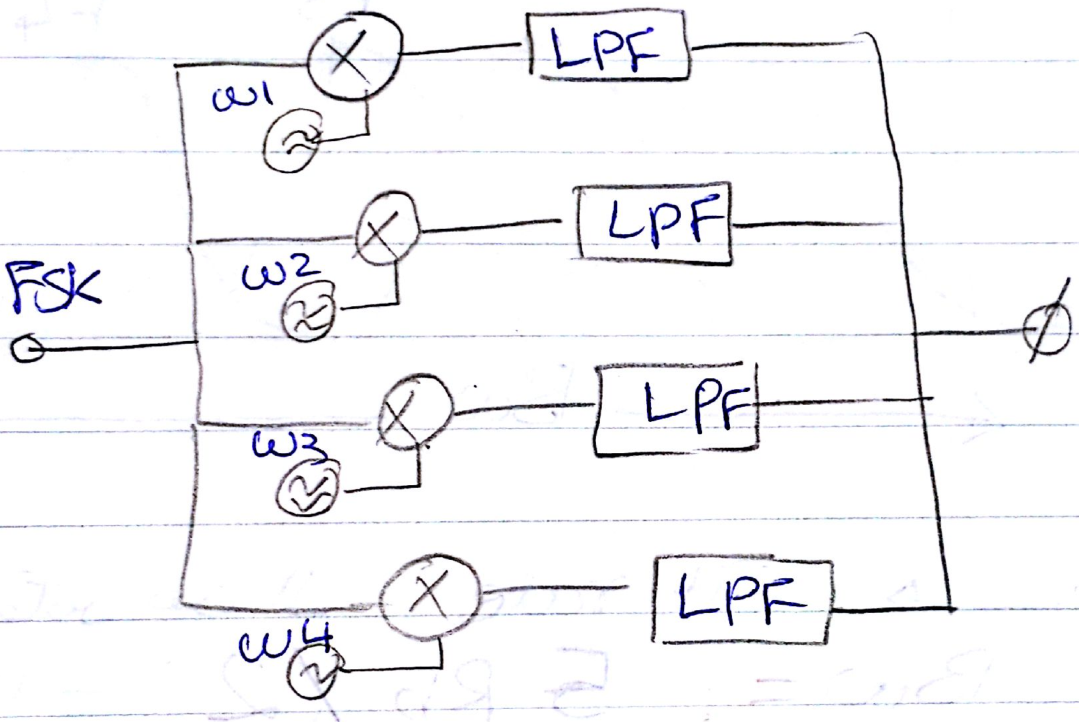
VCO → voltage control oscillator (Fm)

Baud rate: number of simples per second

Bit rate ≅ number of samples per second

>8 amplifier

block diagram of detector of 4 FSK



voltage logic ① only one channel is opreated because :-

$\frac{1}{2}$ $\cos\omega_1 t * \cos\omega_1 t = \frac{1+\cos 2\omega_1 t}{2}$

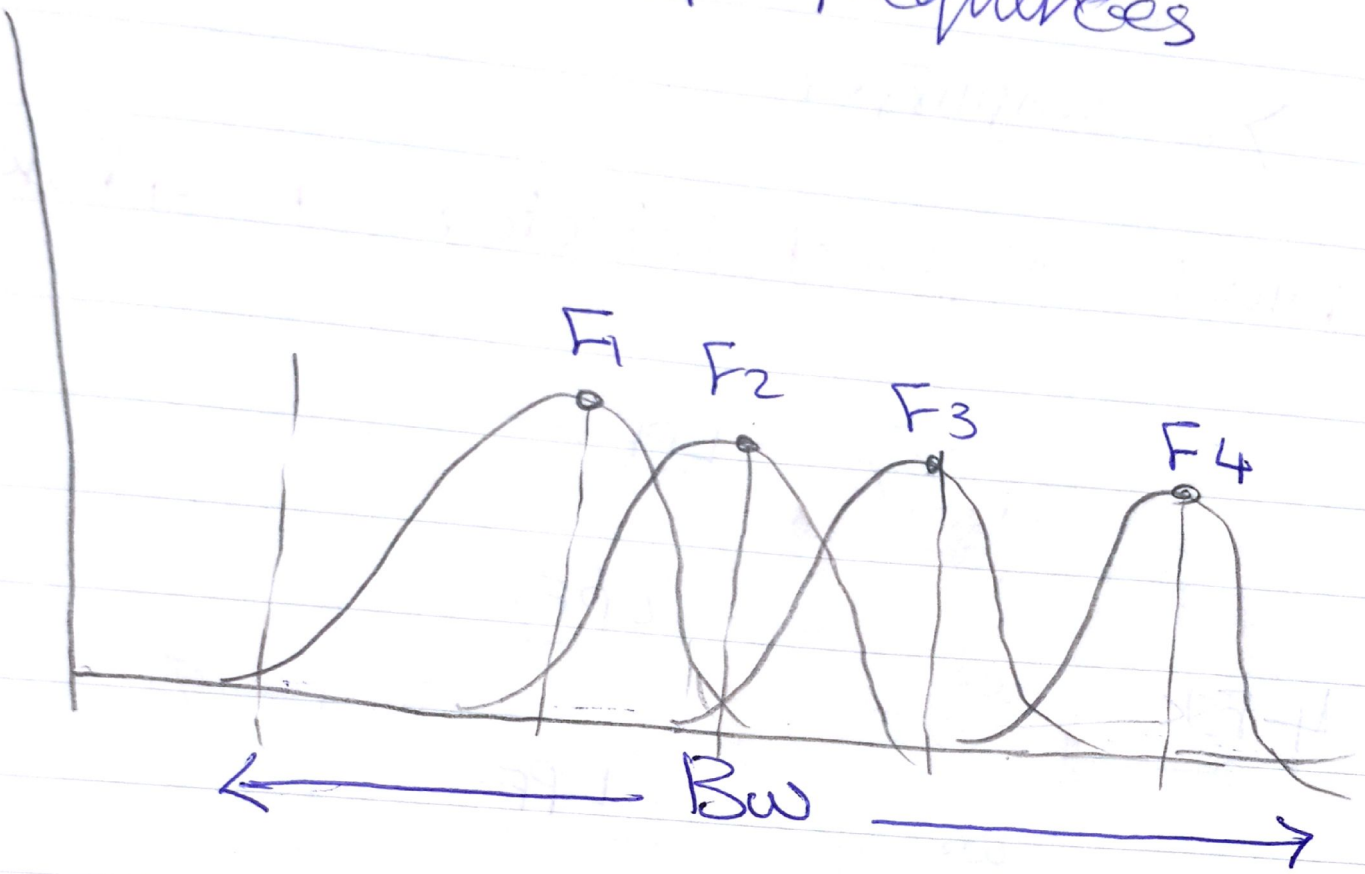
we have DC ⟶ plus طاقة ال

$\frac{1}{2}(\cos(\omega_1-\omega_2)t + \cos(\omega_1+\omega_2))$

$\cos\omega_1 t * \cos\omega_2 t$ = 2 high frequency the low pass filter don't passes them

Orthogonal 4 Fsk

There are 4 Frequencies



Bw ⟵ bit rate تقاس ب ال

$Bw = 5\,Rb / 2 = 5RB$

2 bit / 2 bit

او

Example-

IF the lowest Frequency = 95MHz & Rb = 10Mbp find the highest frequeey to be reached after modulation.

Bw = 5 x 10Mbp/2

=

digital Phase Modulation

The phase of the carrier will vary with digital sigal (0,1)

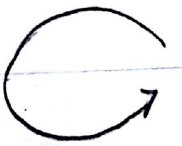
- the out put have 2 phases
- one phase dependon to 0
- seconcd phase dependon to zero

let us discribe the Phase with a vector diagram or phase diagram.

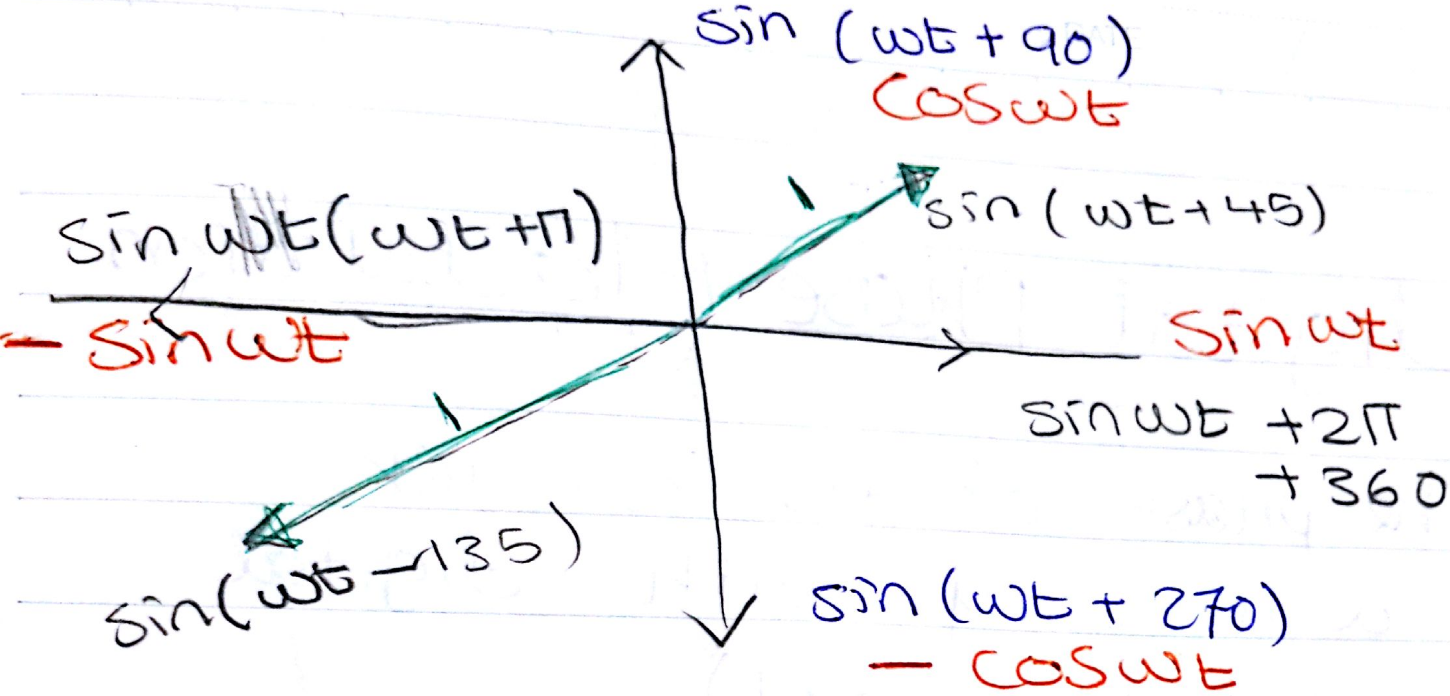
The phase range from 0 to 360°

The vector star with x axis and rotate counter block wise.

magnitud = 1 للشيط



let this x axis represents the carrer Frequency sin ωt → the phase when we started zero من اذ بدأت



we mean that the Phase of sin wt will change with the digital signal.

مهما زدت النقشة ح تتحرك
عن القمة

اذا كان لست اوه تكمه لدين
2 phases or 2 vector

$-\sin wt - 90^\circ = \cos wt$

* BW → Buad rate

BPSK

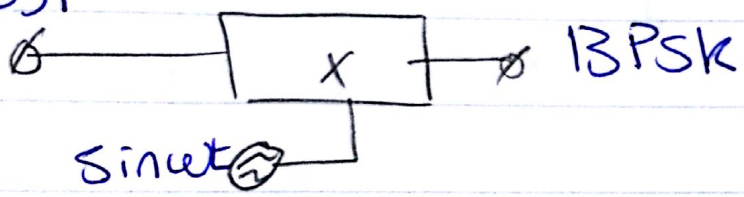
Binary Phase shift keying

Phase

block diagram

digital input

0 or 1



x ← balanced modulator ← product ← Amplitude

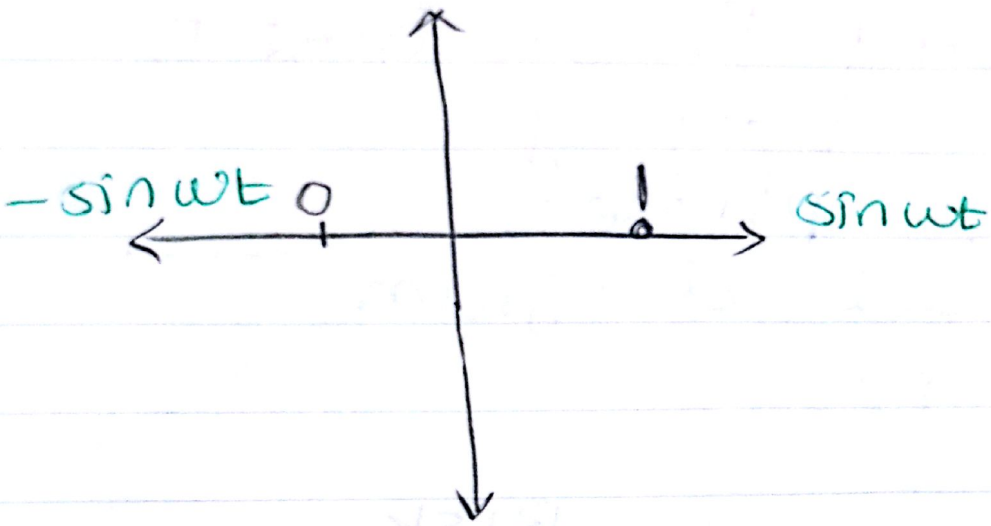
out of phase 0 → represent by −1v

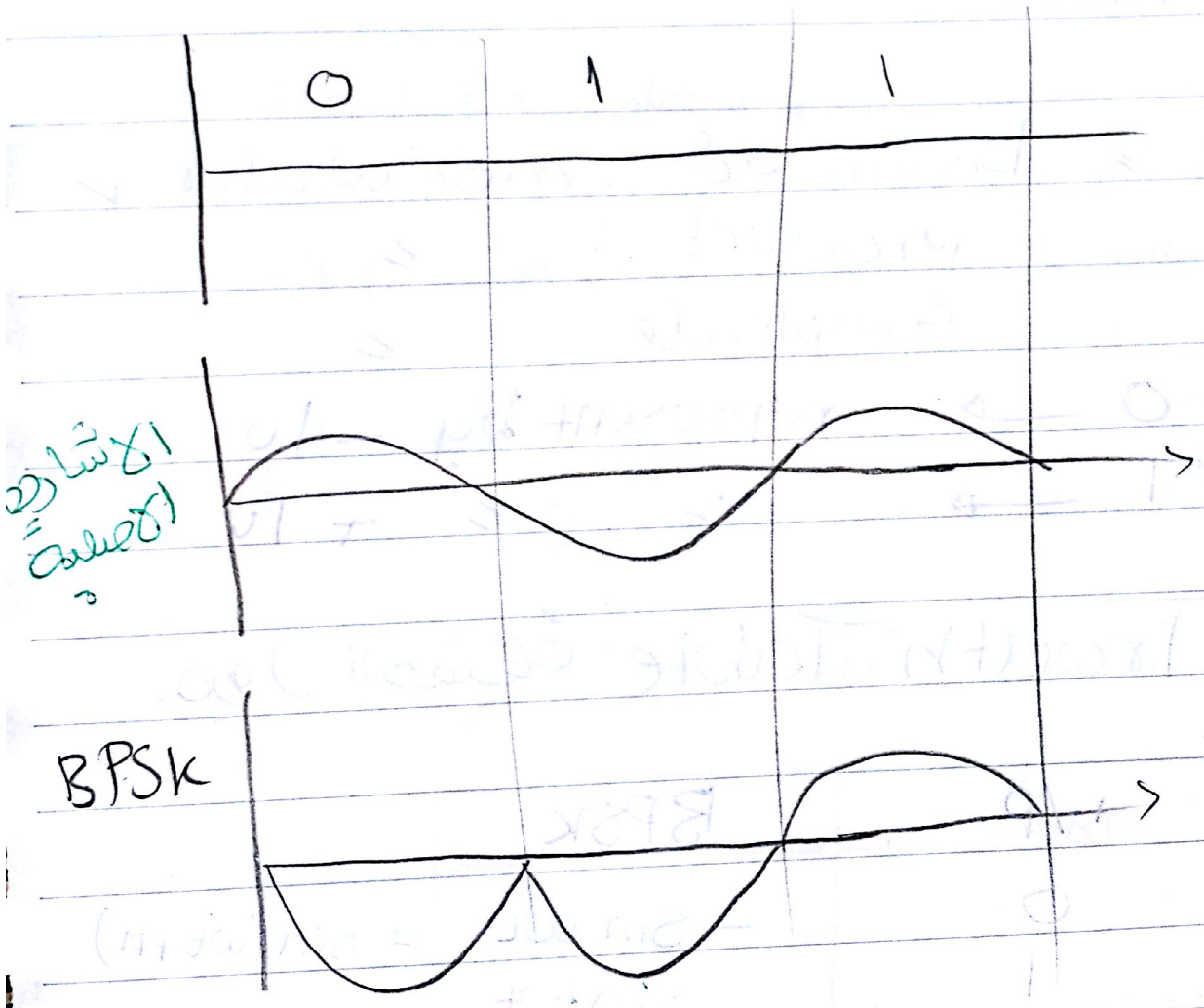
in phase 1 → " " +1v

Truth Table جدول الحقيقة

I/P	BPSK
0	$-\sin \omega t$
1	$\sin \omega t$

$= \sin(\omega t + \pi)$

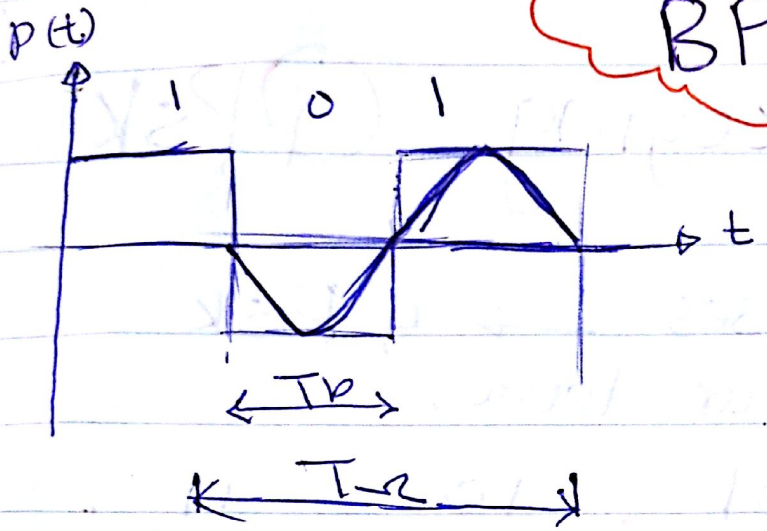




1 ⟶ no Toggle يعمل ∆

0 ⟶ Toggle

Bandwidth BPSK

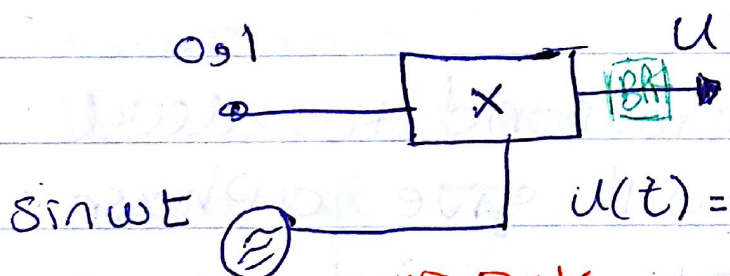


$$Rb = \frac{1}{Tb} = \frac{1}{TB} = RB$$

$$T_{-\Omega} = \frac{1}{F_{-\Omega}} = 2Tb$$

$$F_{-\Omega} = Rb/2 = RB/2$$

BPSK modulator:

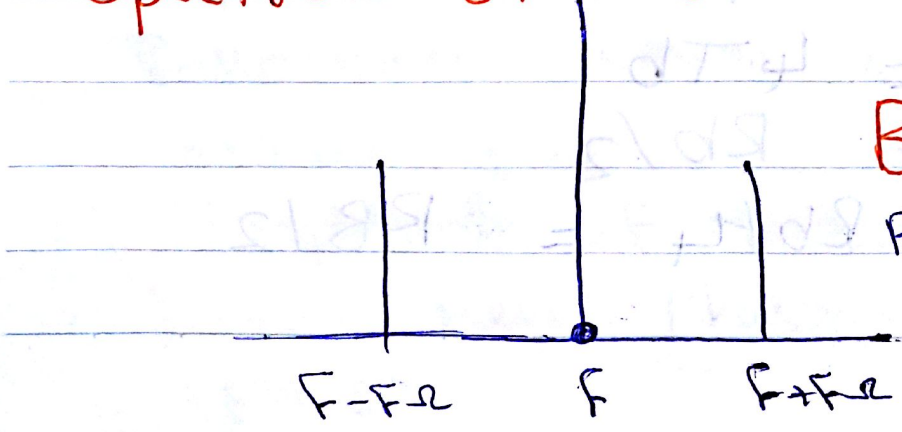


carrier signal

$$u(t) = \sin 2\pi F_b t \cdot \sin 2\pi f_{ct}$$

$$u(t) = \frac{\cos 2\pi (F - F_{-\Omega})t}{2} \quad \frac{\cos 2\pi (F + F_{\Omega})}{2}$$

Spectrum BPSK:

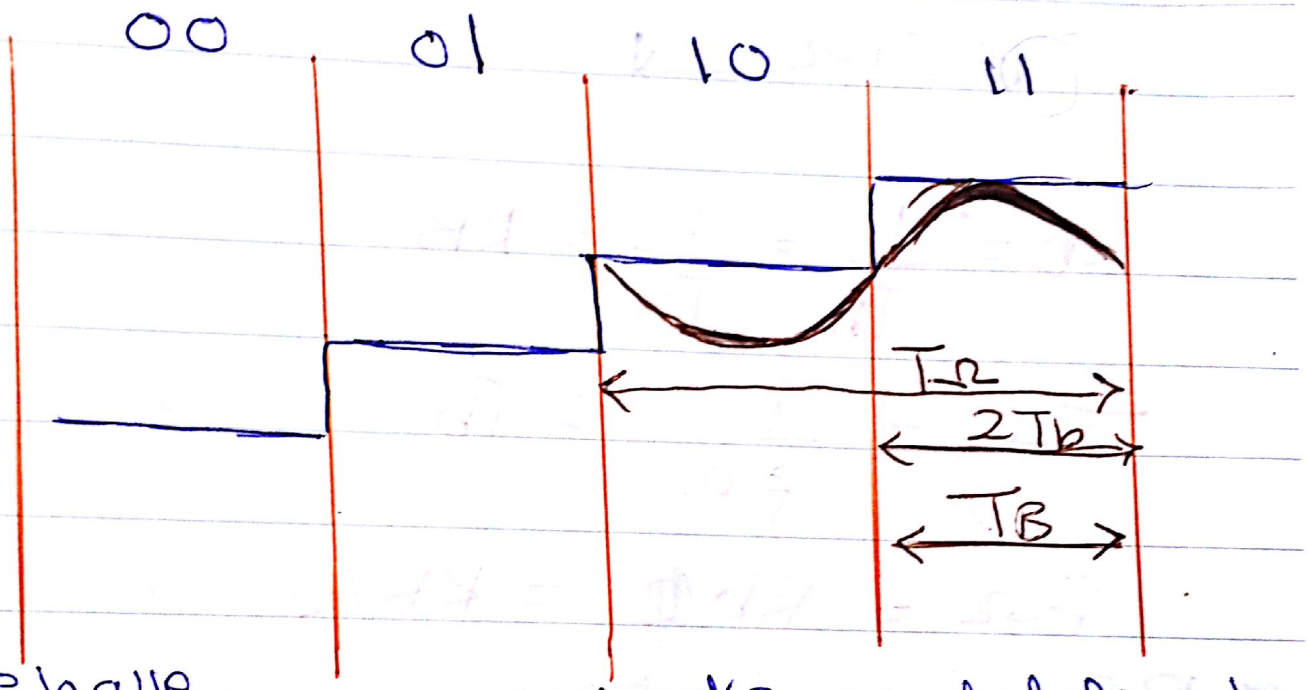


$$Bw = 2f_{-\Omega} = R_b = R_B$$

Bw From Buad rate and not From the bit rate.

Quadrature Phase Shift keying QPSK

we have 4 Phases → 4 PSK
we need Four levels



we have make modulation to the carrier.

each 2 bits crospond to alevel
each level will give aphase

$TB = 2Tb$

$T\Omega = 4Tb$

$RB = Rb/2$

$F\Omega = Rb/4 = RB/2$

QPSK

1- Block diagram
2- Truth Table
3- Phase diagram
4- Detector
5- spectrum & Bw
6- Example

M-ary
bit's number

The subject As aquestion : draw a block dragram of a QPSK modulator and obtain From it the truth table and Phase diagram. Explane the structure and operation of a QPSK detector. a digital signal with 8Mbps is transmitted using QPSK modulator If the data sequence in phase channel I = 1 and Quad Phase channel Q = 0 - determine the following when the carrier is sin wt :

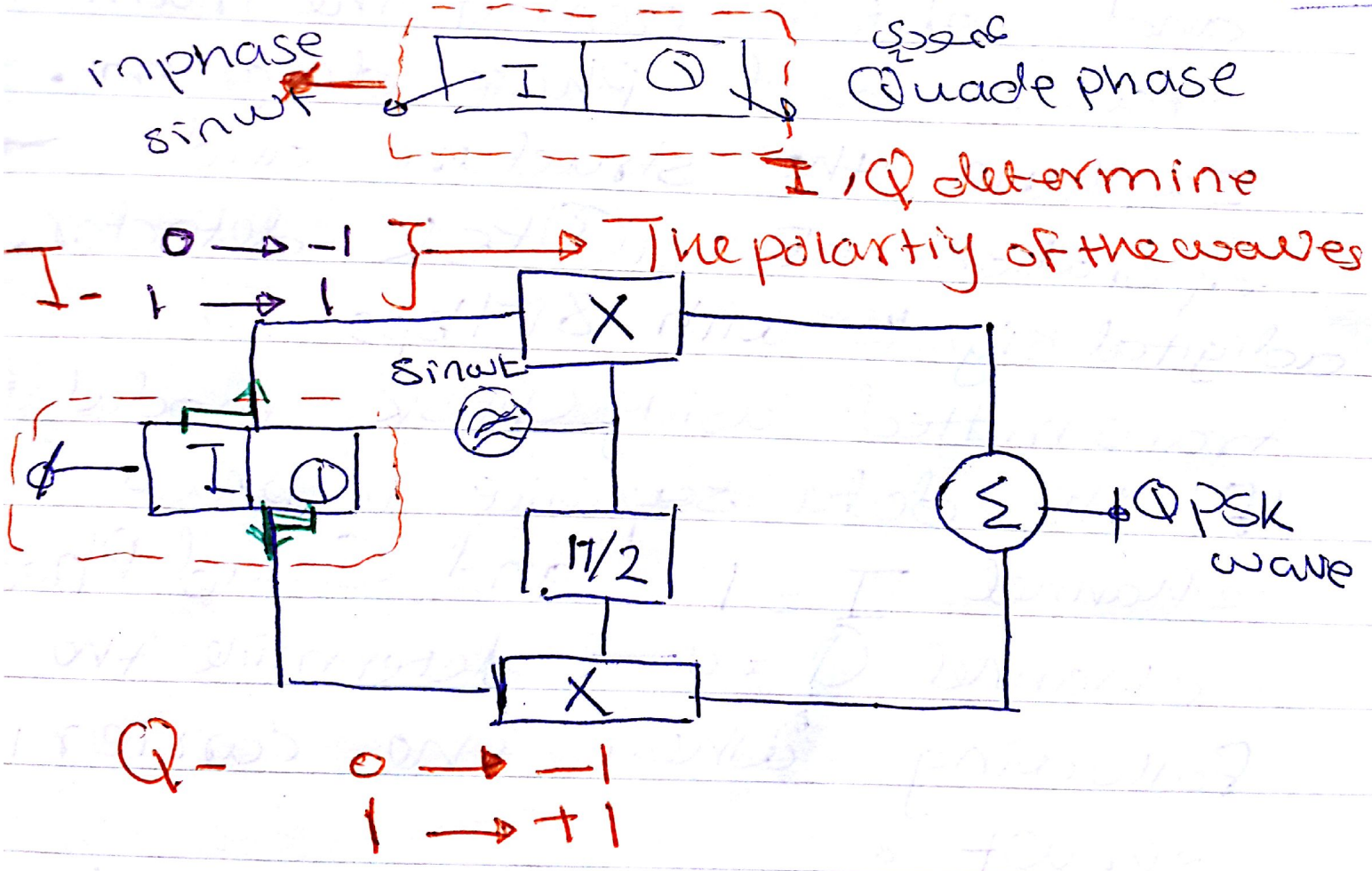
1- Amplitude of the modulated wave
2- The new phase of the modulated phase

3- The Bw of the modulated wave

4- The highest frequency to reached after modulation.

5- sketch the wave form of the output directly below the carrier wave.

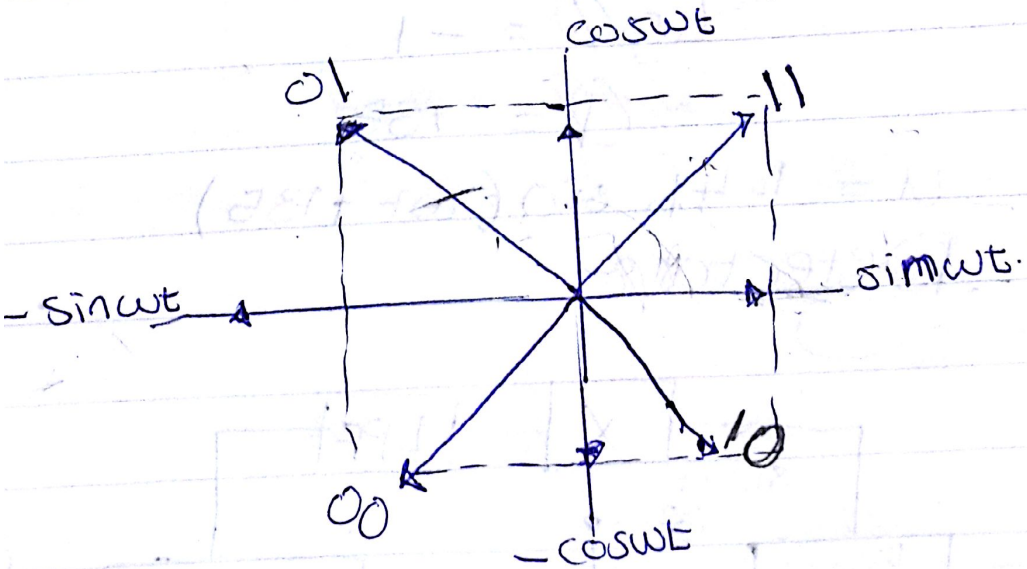
(we want 4 leveles → is done by taken 2 bits instead of one by aserial to parrllel convertor)



I	Q	QPSK wave (with 4 Phase)	
0	0	$-\sin\omega t - \cos\omega t$	-135°
0	1	$-\sin\omega t + \cos\omega t$	135°
1	0	$\sin\omega t - \cos\omega t$	-45°
1	1	$\sin\omega t + \cos\omega t$	45°

The angle was $\sin\omega t$

phase diagram



11 → sin (ωt + 45)

01 → cos (ωt + 135)

11 → 1-41 sin (ωt + 45)

01 → 1-41 cos (ωt + 135)

X

العود و

sin (ωt +

جا	كل
ظا	جتا

$\frac{360}{4} = 90°$ والفرق phase المقابين ال

Find the wave of QPSK if I = 0, Q = 1

$u = -\sin\omega t + \cos\omega t = A\sin(\omega t + \phi)$

[redacted]

$u = A\cos\phi \sin\omega t + A\cos\omega t \sin\phi$

$A\cos\phi = -1$

$A\sin\phi = 1$

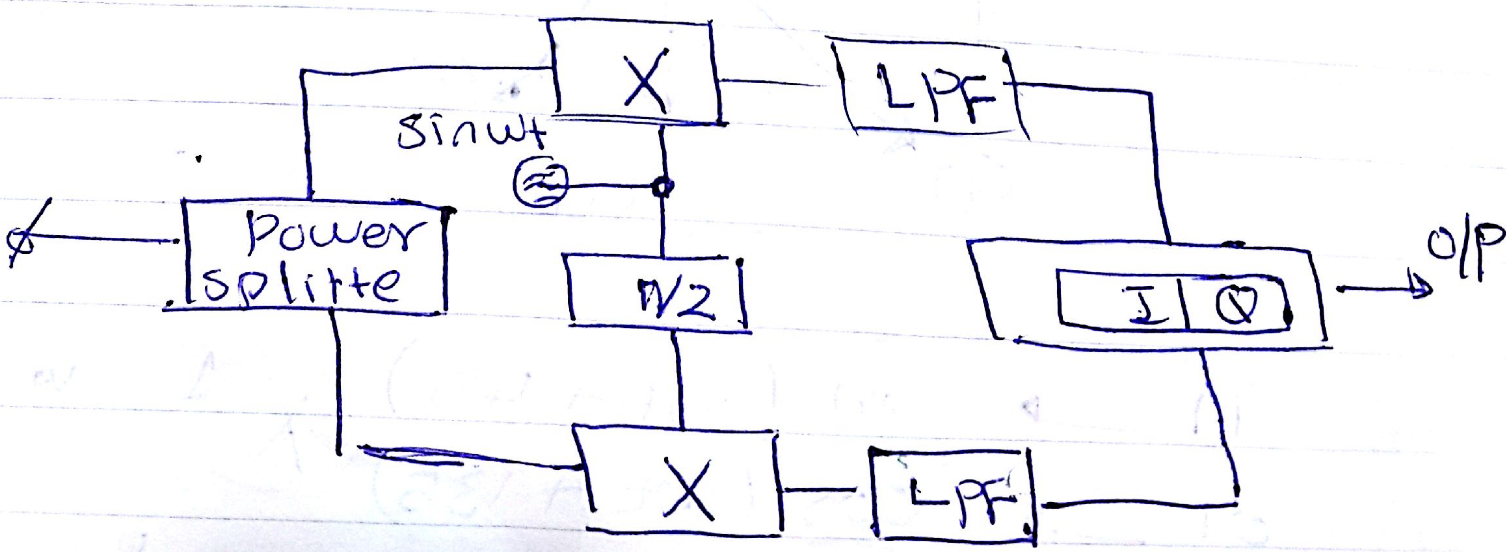
$A = 1.41$

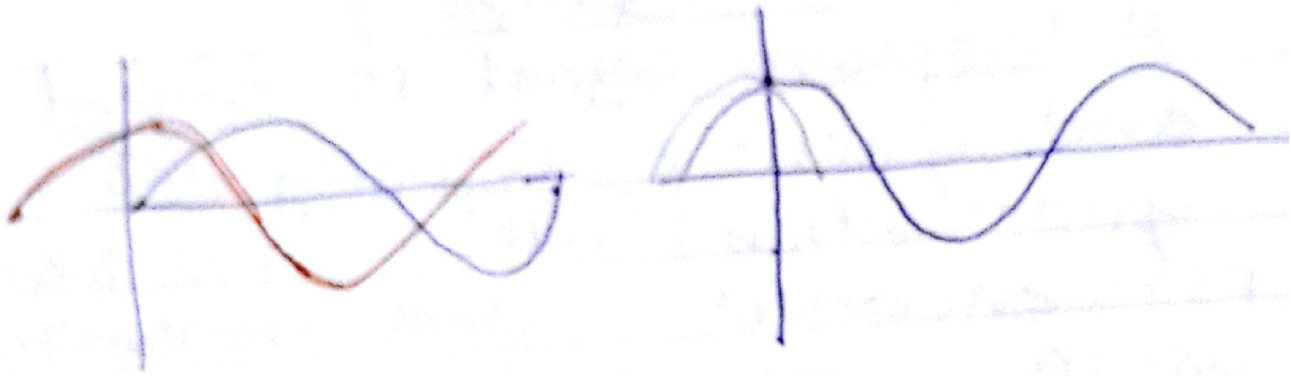
$tg\,\phi = -1$

$\phi = 135$

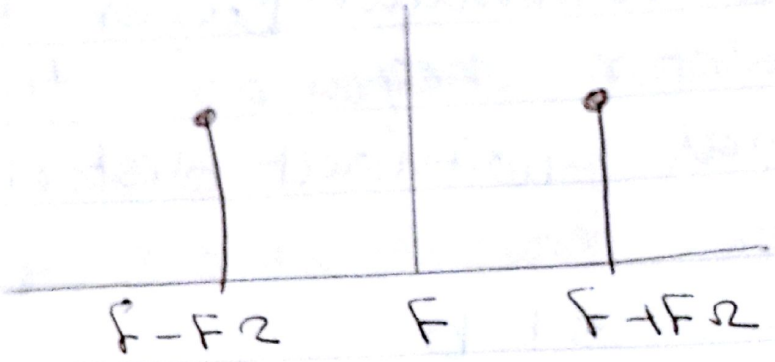
$u = 1.41 \sin(\omega t + 135)$

Detector:



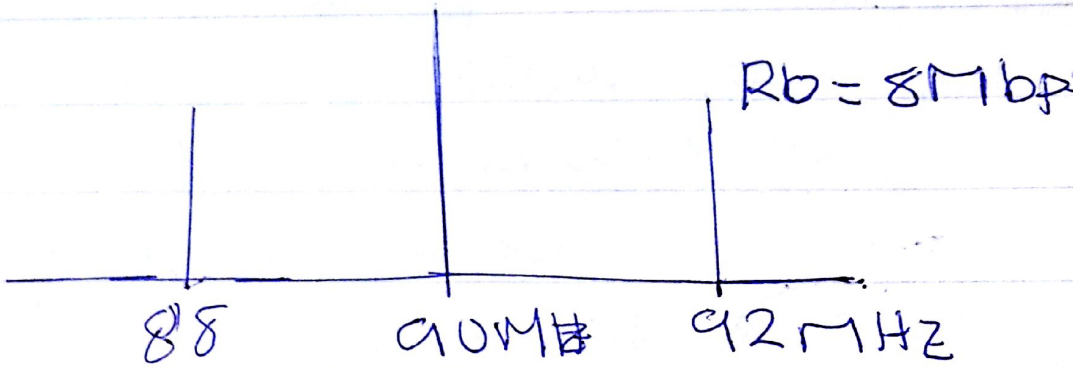


spectrum



$f_{-\Omega} = Rb/4$

$Bw = Rb/2 = RB$



$f_{-\Omega} = 92MHz$

$f_{-\Omega} = Rb/4 = 8/4 = 2$ $Bw = 92 - 88 = 4$

$Bw = 2F_2 = 2 \times 2 = 4$

Quiz

A telephone signal is simpled and quantized using 128 quantization level. The signal is encoded and transmitted using orthognal BPSK modulation. Find the minimum Bw of the modulator required to transmit the signal without distortion.

$$Bw = 2Rb + 2\Delta f$$

$$Bw = 3Rb$$

$L = 128$, $n = 7$, $Rs = 8$ ~~KHz~~

$$Rb = Rs \times n = 8000 \times 7$$

الاشفال بزاحة الطور الثماني

8Phase Shift Keying

8PSK

- what is relation between simple rate and bit rate in 8PSK?
- Draw a block diagram of an 8PSK and explain in detail is operation
- obtain from this diagram the truth table Phase diagram, space diagram.

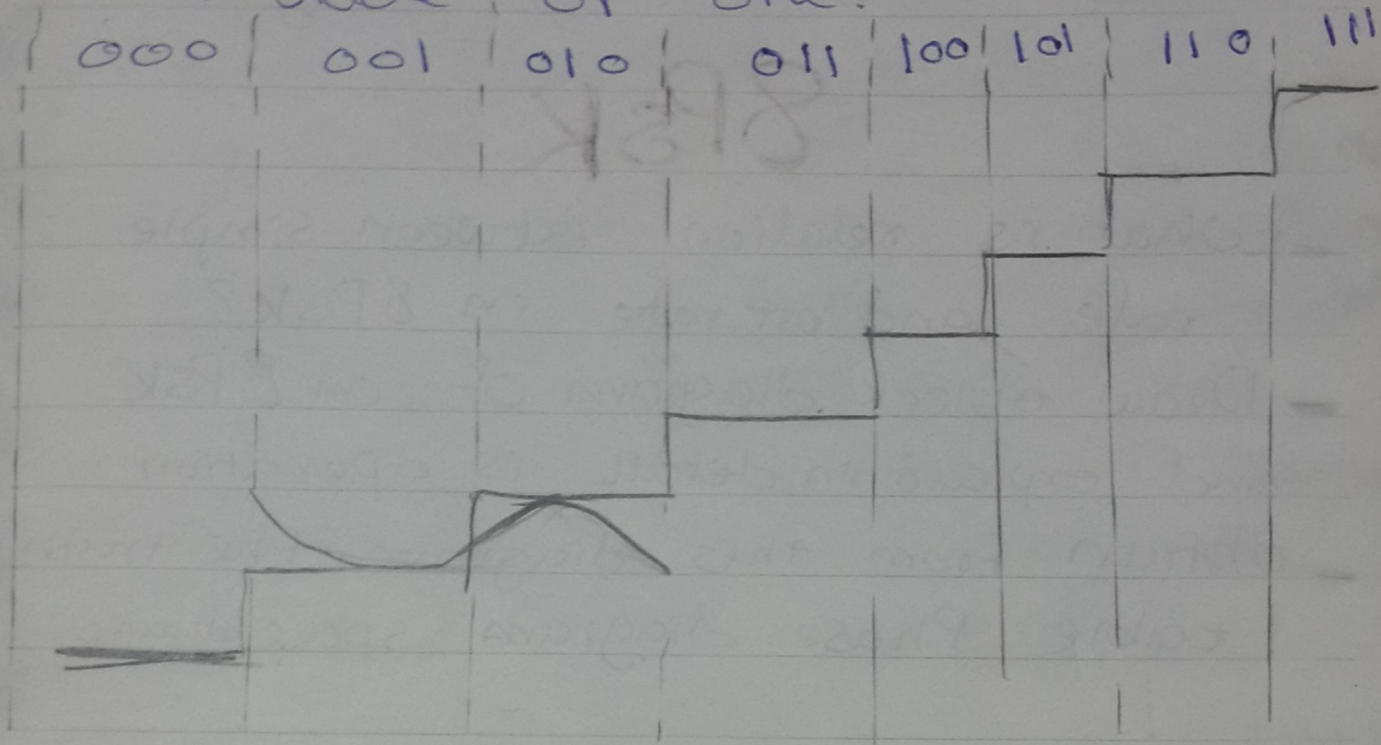
a digital sequence

I = 0 , Q = 1 , C = 1

with bit rate equal 5Mbps is transmited using 8PSK if the carrier Frequency sinwt = 120MHz determine the following:

1- The Baud rate
2- The Bw of the modulator
3- The amplitude of the modulated carrier.
4- The phase of the output wave
5- sketch the wave form of O/P for 1 cycle.

we take 8 bits at the same time instede of one.

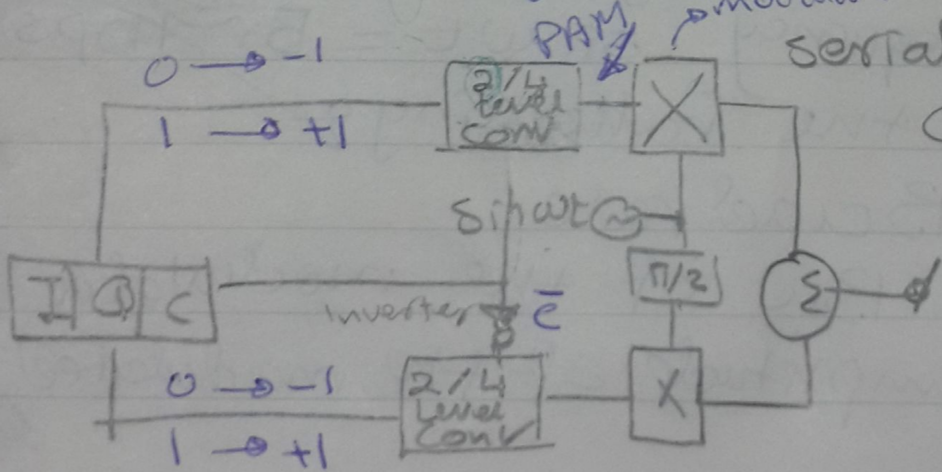


RB = Rb/3

f_{m} = RB/2

f_{Ω} = Rb/6

block diagram by [illegible] serial to parrllel converter



I,Q → لتأثير القطبية

I { 0 → -1, 1 → +1 }

Q { 0 → -1, 1 → +1 }

C = control channel

0 → 0-541

1 → 1-307

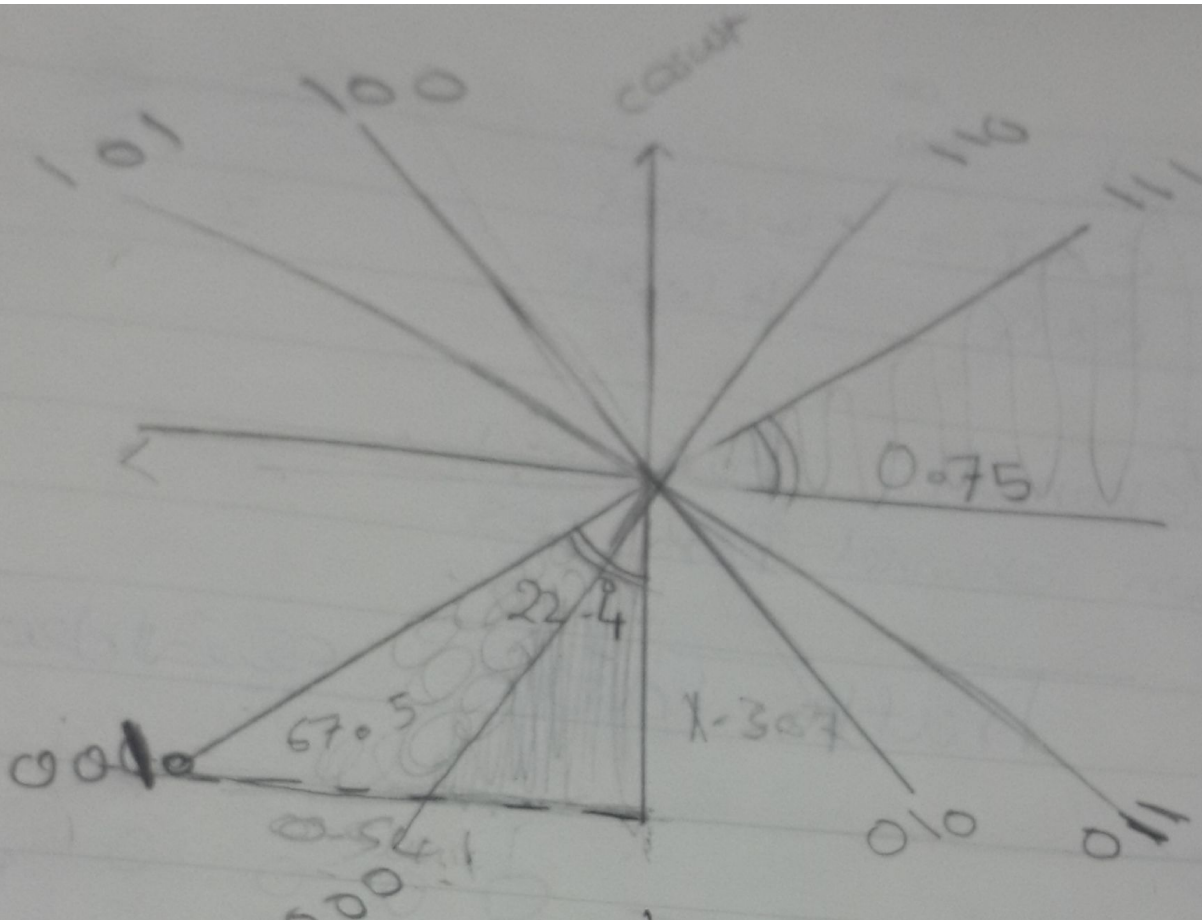
D/A
2/4 Lev

C x I = 4 level
C x Q = 4 level

* up channel for sin
* down channel for cos

Truth Table جدول الحقيقة

I	0	0	0	0	1	1	1	1
Q	0	0	1	1	0	0	1	1
C	0	1	0	1	0	1	0	1
O/P	$-0.541 \sin\omega t - 1.307 \cos\omega t$			$1.307 \sin - 0.541 \cos$		$+1.307 \sin\omega t + 0.541 \cos\omega t$	$0.541 \sin\omega t + 1.307 \cos\omega t$	$1.307 \sin\omega t + 0.541 \cos\omega t$



$$\sqrt{(0.541)^2 + (1.307)^2} \qquad \tan^{-1}\frac{0.541}{1.307} = 22.4^\circ$$

$22.4 + 90 = 112.4$

$1.041 \sin(\omega t - 112.5)$

لانها في الربع الثالث

0.75 → 110

(& Phaso showd be draw)

IQC
001

$-1.307 \sin \omega t - 0.541 \cos \omega t$

≠ the sum of any 2 sinsoid is sinsoid $A \sin(\omega t + \phi)$

$A \sin \omega t \cos \phi + A \sin \phi \cos \omega t$

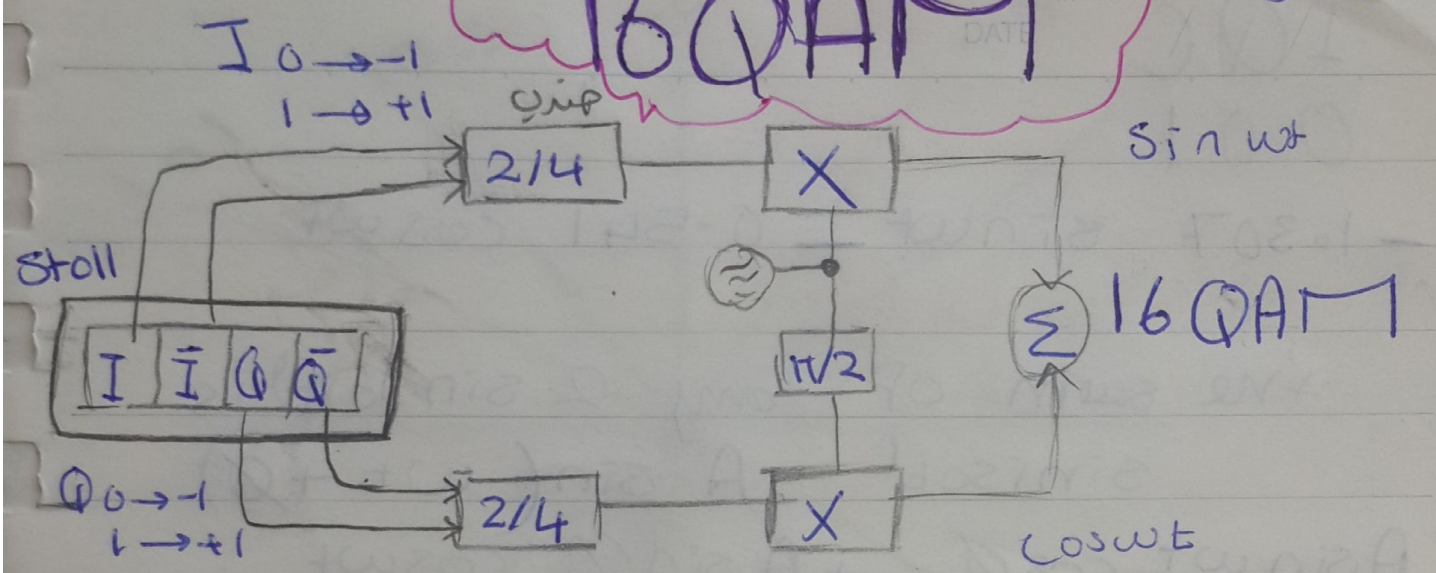
$A \cos \phi = 1.307$

$A \sin \phi = 0.541$

$A = 1.41$

$A \sin \phi = -0.541$

16QAM



* Change in Phase & Amplitude

0 ⟶ 0-220

1 ⟶ 0-821

* num of channels = 2 Channel
* num of Phases = 12 Phases

Amp وجود سبب ⟵ 30° بين phase

* we take 4bits by serial to parrlel converter (16 level)
* I ⟶ inphase channel

carrier : sinwt

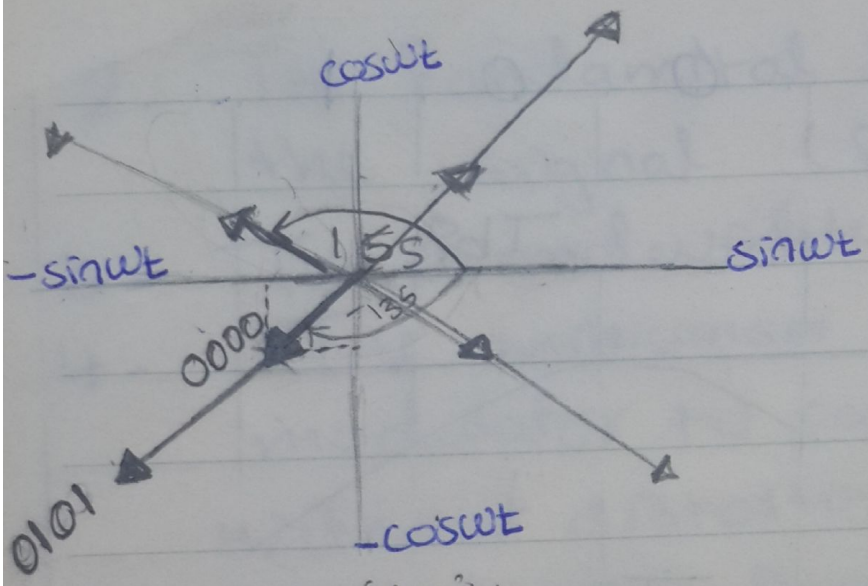
* I, Q ⟶ Polarity

Ī, Q̄ ⟶ control channel to change the level

Examples

* 0000 ⟶ − 0-220 sin wt − 0-220 cos wt

$\Phi = -135°$, A = 0-311 , U = 0-311 sin(wt-135°)



الشكل

* $I=0, \bar{I}=1, Q=0, \bar{Q}=1$

$-0.821 \sin\omega t \quad -0821 \cos\omega t$

$\theta = -135°$

$A = 1.16 = \sqrt{(0.821)^2+(0.821)^2}$

$U = 1.16 \sin(\omega t - 135°)$

Examples Obtain the equation of the o/p of a 16QAM if $I=0, \bar{I}=1, Q=1, \bar{Q}=0$

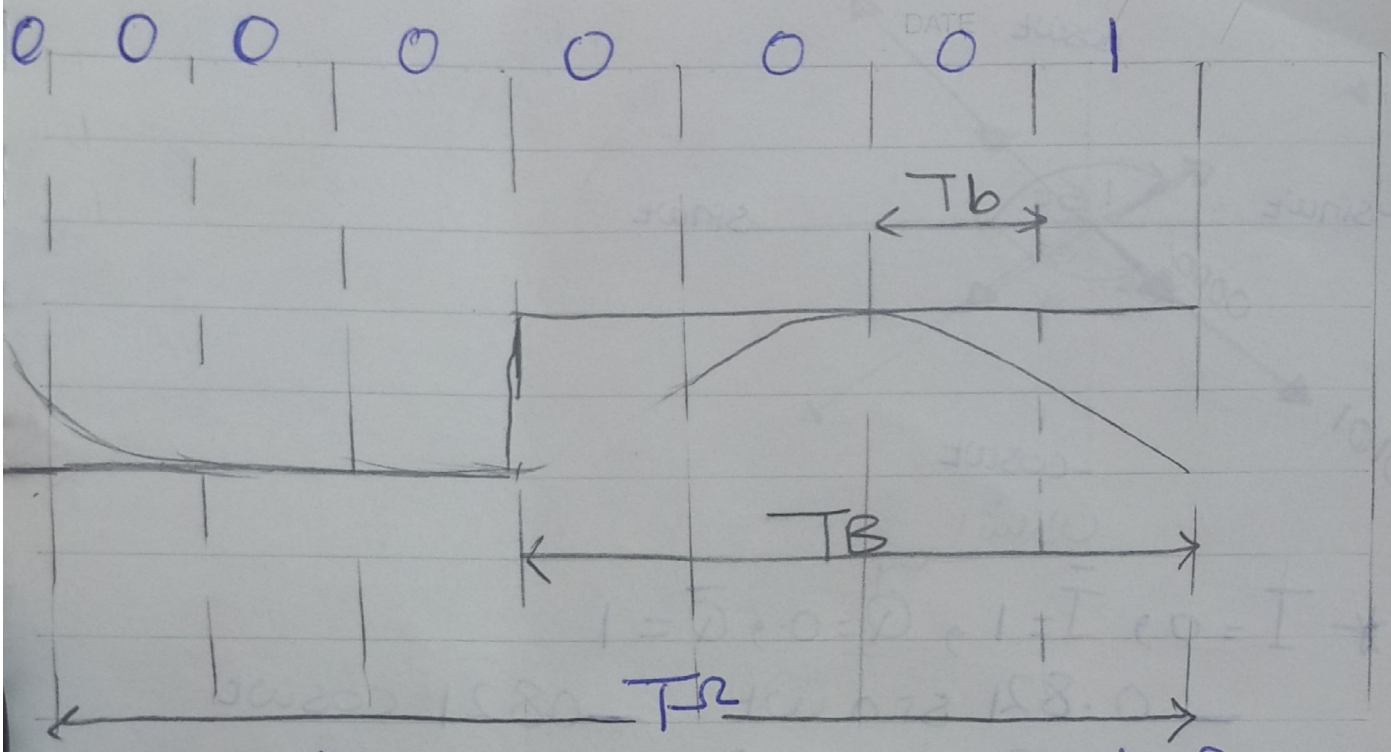
$-0.821 \sin\omega t + 0.220 \cos\omega t$

$\tan^{-1} \frac{0.821}{0.220} = 74.9° + 90$

$= 165°$

$A = 0.85 \sin(\omega t + 165)$

level ⟶ 4 bit



RB = Rb/4
FR = Rb/8
Bw = Rb/4 = RB

wave form to the input signal (digital

draw a block diagram of a 16QAM modulator and obtain from it the truth table, the Phase diagram, the space (dot) diagram.
If the sequence is as follows
I = 1, $\bar{I}$ = 1, Q = 0, $\bar{Q}$ = 1 and the carrier Frequency 120 MHz with bit rate 60 Mbps. Explain the structure and operation of the detector of the 16QAM. also determine the following
1. The Baud Rate

2- The Fandamital Freequency of the signal (F-Ω)

3- The Banderidth of the signal

4- The minimam Bw of the modulator to carry the signal without distortion.

5- The higest frequency after modulation

6- write the equation of the output of the modulator

7- sketch the wave form of the o/p of the modulator.

(notes: the carrier to be sinωt)